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A

TREATISE

ON

MINERAL, VEGETABLE, AND ANIMAL

POISONS,

CONSIDERED AS TO THEIR RELATIONS WITH

Physiology, Pathology, and Medical Jurisprudence.

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ROYAL ARMY MEDICAL COLLEGE No. LIBRARY

BY M. P. ORFILA, M. D.

OF THE FACULTY OF PARIS, PROFESSOR OF CHEMISTRY AND NATURAL PHILOSOPHY.

TRANSLATED FROM THE FRENCH,

BY JOHN AUGUSTINE WALLER,

SURGEON.

IN TWO VOLUMES.

SECOND EDITION, CORRECTED.

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THIS TRANSLATION OF

ORFILA'S

GENERAL SYSTEM OF TOXICOLOGY,

IS

RESPECTFULLY INSCRIBED

AS

A SMALL TOKEN OF RESPECT FOR

HIS PUBLIC CHARACTER,

AND

AN ACKNOWLEDGEMENT OF GRATITUDE AND

ESTEEM

FOR HIS FRIENDSHIP AND PATRONAGE,

BY HIS

MOST DEVOTED SERVANT,

JOHN AUGUSTINE WALLER.

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TRANSLATOR'S PREFACE.

THE TRANSLATOR now presents to the public a new and corrected edition of this elaborate and valuable work. He has spared no pains to render it as correct as possible. In order to effect this purpose he has carefully collated every sentence, by which means several inaccuracies that had unavoidably crept into the first edition, have been detected.

His chief endeavour throughout has been, to give to the reader a faithful and literal translation, and, as nearly as possible, in the very words of the accurate author of this work: in doing which he has frequently employed terms not generally used by English writers on the same subjects, yet such as are easy to be understood. *M. Orfila* has every where adopted the latest chemical nomenclature of the French school; and the Translator has judged it most prudent to preserve his language, as far as it is intelligible to an English reader, conceiving it to be the only method of giving a just specimen of his work. So also in the various departments of science of which he treats, he every where employs the most modern technical phraseology, as well as in chemistry; so that in many instances, a close Translation would be almost unintelligible: in these instances, therefore, the Translator has been under the necessity of adhering to the language most usually received in this country. Conceiving that, in a work of this description, ac-

curacy was of more importance than elegance of style, the utmost diligence has been employed to adhere closely to the text; and it is hoped, that the want of elegance of diction will be sufficiently compensated by the accuracy of Translation. In the botanical department of this work, the Translator has been frequently embarrassed and put to great difficulties, from the author's having given only the common French name, and not unfrequently a *provincial* name, to a great number of the plants he takes notice of, without adding the Linnæan, or any other scientific appellation. The same difficulties have frequently occurred in the zoological descriptions, and have caused him considerable trouble to identify with certainty the species of plant or animal intended by the author. No one is ignorant of the deficiency of vulgar languages in this respect, or how many different species of plants and animals are frequently confounded under one common name. No pains however have been spared to insure a correct and accurate Translation, which the importance of the subject demanded; and it is hoped that any small defect that may be discovered in the course of so long and laborious a task, will meet with some degree of indulgence. The notes of the Translator have been few and short; they have never been obtruded, except on passages that most evidently required them. They might indeed have been more numerous, and of greater extent, but he has only ventured to comment on, or correct the author, with a timid hand.

AUTHOR'S PREFACE.

OF all the branches of Medicine, the study of *Toxicology* is, without contradiction, that which excites the most general interest. Allied as it is by numberless relations with almost all the natural Sciences, it has occupied the attention of all Philosophers, who are zealous of contributing to the progress of human knowledge. The Naturalist, placed in the midst of a multitude of poisonous substances, attentively examines the varied forms which they present, their distinguishing characters and their mode of developement, and arrives easily at a method of pointing them out. The Physiologist, inflamed with the desire of unveiling the most secret mysteries of our organization, seeks to explain the mode of action of the most energetic poisons, the deleterious influence which they exert, and the immediate cause of the sudden death they occasion. The Medical Practitioner, aware of the fatal and instantaneous effects, produced by the poisons of the three kingdoms of Nature, constantly directs his attention to the search of means capable of destroying at once their fatal action, and of re-establishing the dif-

ferent functions of the animal economy in their natural order. The Chemist, revolting from the horrid crime of homicide, brings to perfection the process necessary for establishing the case of poisoning, in order to lay open the crime, and to enlighten the Magistrate whose duty it is to punish the guilty. The private individual, sensible to the misfortunes of his fellow-creatures, is fond of discoursing on the fatal properties of poisonous substances, and of the astonishing phenomena they give rise to: alarmed at their destructive consequences, he never ceases to deplore the fate of those who are the victims of negligence or mistake, and to feel for the misfortune of the unhappy wretches whom despair has hurried on to suicide. Incensed at the most cowardly of crimes, he regards with horror the execrable assassin; and loudly demands the punishment of a monster, by so much the more dangerous, as he always commits his ravages in silence, and often even upon his benefactors.

Having given myself up for a long time to the pursuit of this beautiful part of natural history, it appeared to me a useful undertaking to collect into one work, and that not very voluminous, the most prominent objects that belong to it. Such a work is altogether wanting to Science; I may affirm more; a very considerable number of the facts which should serve for its basis, are still unknown, or badly studied.

The Treatises on Toxicology by Plenck and

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Franck, which were published a long time back, are no longer on a level with the present state of knowledge, and can only be considered as very imperfect sketches of this important Science. The Treatises written particularly on arsenic, sublimate, copper, lead, nitric acid, prussic acid, opium, &c., furnish only the solution of certain problems in Toxicology, and ought only to be regarded as so many separate tracts, proper for furnishing excellent materials to the arrangement of some of the materials for a work of this kind.

I must confess I have been often discouraged by the blanks I had to fill up, and should several times have abandoned my undertaking, had I not been convinced that it is always useful to attempt to clear the path, even when imperfectly marked out.

This Treatise, consisting of two volumes, 8vo. will be divided into two sections, preceded by an introduction, in which will be pointed out in a succinct manner, the end of Toxicology, its relations with the other Sciences, and the means to be pursued for bringing the study to perfection; lastly, the division of poisons into six principal classes: The Corrosive, the Astringent, the Acrid, the Narcotic, the Narcotico-acrid, and the Putrifying.

The first section will contain the particular history of the different poisonous substances, drawn from the three kingdoms of Nature, and considered under their relations with Chemistry, Physiology, Pathology, and Medical Jurisprudence.

In giving this history, we shall begin by establishing some generalities in each of the six classes. For instance, the action of corrosives upon the animal economy will be explained, with the different causes of the death which they produce, the general symptoms they exhibit, the lesions of texture they occasion, finally, the treatment proper to be pursued in order to relieve the symptoms to which they give rise. Afterwards each of the Poisons will be separately treated of, attending more particularly, to those which present the greatest interest. Their history will be comprised in the six following paragraphs.

1*st.* *An Explanation of their Chemical Properties, and of their external Characters.*

This part, which has been neglected by all the writers on Toxicology and Medical Jurisprudence, will be laid down with the greatest care. Among the different characters proper for recognizing these substances, those will be selected which are the most constant, and the easiest to verify. The precipitates furnished by the mineral poisons, when mixed with the different Chemical Re-agents, will be particularly attended to: their colour, their nature, and the mode of analysing them, will be explained. The theory of the formation of those precipitates, being alone able to enlighten the Juridical Physician on the poison he is desirous of being acquainted with, care will be taken to explain it

after having laid down the phenomena which they present; by this means, the person called on to decide, far from proceeding empirically, will judge always with a knowledge of the cause, and thus arrive at sure results. The botanical and zoological characters of the different vegetable and animal poisons, will be laid down according to the principles of the two Sciences to which they belong.

2nd. *Their Physiological Action.*

In this paragraph will be determined, the effects of poisonous substances when administered in doses capable of producing serious accidents: the experiments will be reported, which have been made upon living animals, with the intention of ascertaining the phenomena they produce when introduced into the stomach, when injected into the veins, or when externally applied. By the help of the phenomena resulting from these kind of researches, it will be explained, as far as the present state of Physiology will allow, by what mechanism death supervenes in the animals poisoned.

3rd. *Their general Symptoms.*

The enumeration of these symptoms will be preceded by some cases and observations on the kind of poisoning. These observations, which will be drawn from the works of Dioscorides, Paré,

Manget, Morgagni, Hoffmann, Sydenham, De Haen, &c. will enlighten the practitioner on the diagnosis, and on the mode of treatment which he ought to pursue.

4th. *The Lesions of Texture which they produce.*

The nature of the alterations produced by the poison, their situation, their extent and intensity, will form the subject of this paragraph; in which it will be attempted to demonstrate, from the appearances on dissection, that it is impossible to be able to recognize, by the simple inspections of lesions of this description, the poisonous substance which has produced them.

5th. *The Application of the Facts established in the four preceding paragraphs, to the different Cases of Medical Jurisprudence.*

A. The course which the person called upon ought to pursue when the patient poisoned is living, and that the rest of the poison whether solid or liquid is found, whether alone or mixed with aliments and medicines.

B. The means he ought to employ should the patient be alive, the whole of the poison swallowed, and the matter vomited can be examined.

C. The conduct he ought to pursue in case the whole of the poison has been swallowed, and that

it is impossible to procure the matter vomited, the patient being still alive.

D. The mode of analysis which must be had recourse to when the patient is dead.

6th. *The Treatment of Poisoning.*

As it is of the utmost importance that the practitioner should be acquainted with the different counter-poisons, and beside that a multitude of reagents have been extolled, which do not in any manner deserve the name of *Antidote*, we shall begin by resolving the following problem.

Does there exist any substance which possesses the properties required to act as an antidote?

The numberless experiments which have been made upon living animals, with the design of throwing a light upon this question, will be here reported. It will be made to appear that it is useless, and often dangerous, to have recourse to a very considerable number of those things which have been extolled; and others will be substituted in their room, the employment of which does not present any inconvenience, and may be followed with success; which we shall demonstrate by some facts peculiar to ourselves.

After having thus fixed the respective value of the substances considered as counter-poisons, the course which the Physician ought to pursue in order to

relieve the symptoms developed by the poison will be pointed out, in making the different means understood, which he may employ according to the nature and violence of the symptoms.

The second section will comprise all that relates to poisoning generally considered. This section will contain two chapters.

In the first, the means proper for ascertaining the existence of poison in a person while living, will be treated of.

The first article of this chapter will be set apart for the purpose of making known those symptoms, which distinguish acute poisoning from several other diseases; such as the *Cholera morbus*, the *melæna*, &c.: of explaining the variations of those symptoms, according as vomiting shall, or shall not have taken place: lastly, of determining the degree of confidence which ought to be attached to the experiments, in which animals are made to swallow the matter vomited by the patient suspected of being poisoned.

In the second article, an important question will be treated of, namely, to what class the poison belongs; and if it be a Corrosive Poison, what is its peculiar nature, and consequently, what is the mode of analysis that should be employed for discovering it; what are the precautions that ought to be taken in this important operation; in what order the re-agents ought to be employed, when the poison happens to be in a very small quantity; in what manner, proceeding on from a known to

an unknown point, we may at length be able to decide upon its composition.

In the third article will be given the history of slow poisoning; cases will be communicated, which prove how difficult the diagnosis is; and the different means will be pointed out, by the aid of which, the Juridical Physician may be able to pronounce a judgment that is certain, and beyond the reach of all reproach.

In the second chapter, whatever relates to the examination of the dead body of a person poisoned, will be treated of.

The first article of this chapter will have for its object, the manner of proceeding in the opening of bodies; the importance that the Juridical Physician ought to attribute to the lesions of texture produced by the different classes of poisons; the different states of these lesions in bodies already corrupted, and in those examined shortly after death; whether the poison has been taken during the life of the person, or has been introduced after his decease.

The second article will comprise all the researches proper for establishing a distinction between sudden deaths produced by an internal cause, and those which are the result of the agency of poisons. The lesions of texture exhibited by the dead bodies under these two circumstances, which are altogether different, will likewise be compared.

The work will be concluded with a code of

directions upon the art of preparing the different tests spoken of in the particular history of the six general classes of poisons. By this means, the Juridical Physician will be able to employ with advantage, the substances of which he knows the composition; he will have it in his power to procure them under all circumstances; lastly, he will know what is their degree of purity, and what confidence ought to be placed in the results obtained from their employment.

TABLE OF CONTENTS

OF

THE FIRST VOLUME.

Page

INTRODUCTION 1
Class 1st. Corrosive Poisons 5
Class 2d. Astringent Poisons 7
Class 3d. Acrid Poisons . . . . . ibid.
Class 4th. Stupifying Poisons 9
Class 5th. Narcotico-acrid Poisons 10
Class 6th. Septic Poisons 12

SECTION I.

Of Poisons in particular, their chemical properties, their physiological action, the symptoms to which they give rise, the lesions of contexture which they produce, and the treatment of poisoned persons 13

CHAP. 1st. CLASS 1st.

Of Corrosive Poisons 13
General Action of Corrosive Poisons 14
General symptoms produced by Corrosive Poisons . . . ibid.
Lesions of texture produced by the Corrosive Poisons . . 15
General treatment of persons poisoned by Corrosive Substances 18

ARTICLE 1st. SPECIES 1st.

Mercurial Poisons 19

Page
Chemical History of Mercurial Poisons 21
Of Mercury . . . . . .ibid.
Of the Mercurius Dulcis 22
Chemical History of Corrosive Sublimate 25
Action of Corrosive Sublimate taken internally 47
Symptoms peculiar to Corrosive Sublimate 51
Observation 1st . . . . . .ibid.
Observation 2nd 55
Observation 3d 56
Observation 4th 57
Observation 5th 58
Observation 6th 59
Observation 7th . . . . . .ibid.
Other Observations . . . . . .ibid.
Lesions attributed especially to the Corrosive Sublimate . 61
Application of all that has been said to the various Cases of poisoning by Corrosive Sublimate 63
First Case.—The person is living: the remainder of the poison can be procured 64
Second Case.—The person is living: all the poison has been swallowed: the matter vomited can be examined . . . 66
Third Case.—The person is living: the whole of the poison has been swallowed: the matter vomited cannot be examined 71
Fourth Case.—The person is dead . . . . . .ibid.
Treatment of poisoning by Corrosive Sublimate 74
Antidotes to Corrosive Sublimate proposed by M. Navier . 75
Examination of other substances proposed as Antidotes to this Salt 78
Conclusions drawn from the experiments made with Albumine 84
Of the Red Precipitate and Precipitate per se 90
Of Turbith Mineral 91
Of other Mercurial Salts 93
Mercurial Vapours, and Mercury in a state of extreme division . . . . . .ibid.

ARMY MEDICAL LIBRARY CEYLON

Page

Observation 94

Article 2nd. Species 2nd.

Arsenious Poisons 99
Of Arsenic 101
Chemical History of Arsenious Acid 103
Action of Arsenious Acid upon the Animal Economy . . 113
Symptoms of poisoning produced by the Arsenious Acid.
Observation 1st 116
Observation 2nd 120
Observation 3rd 123
Observation 4th 125
Lesions of texture attributed especially to the Arsenious Acid 127
Application of all that has been said to the various cases of poisoning by the Arsenious Acid 130
First Case.—The patient is living: the remainder of the poison can be procured . . . . . ibid.
Second Case.—The patient is living: the whole of the poison has been swallowed: the matter vomited may be submitted to experiment 132
Third Case.—The patient is living: the whole of the poison has been swallowed: the vomitings cannot be procured 134
Fourth Case.—The patient is dead . . . . . ibid.
Process of Hahnemann . . . . . ibid.
Process of Rose 135
Process of Roloff 136
Process of Fischer 137
A method of discovering the Arsenious Acid after the death of a patient poisoned by this substance . . . . . ibid.
The treatment of persons poisoned by the Arsenious Acid 141
Of the Arsenites 153
Of the Arsenic Acid 154
Of the Arseniates 156
Of the yellow and red Sulphurets of Arsenic . . . . . ibid.

Page
Of the Black Oxyde of Arsenic 159
Of Fly Powder 160

Article 3rd. Species 3rd.

Of Arsenical Vapours 161
Antimonial poisons 162
Of Antimony 163
Of Tartar Emetic 165
The Action of the Antimoniated Tartrate of Potash upon the Animal Economy 169
Symptoms of poisoning by the Antimoniated Tartrate of Potash 173
Observation 1st . . . . . ibid.
Observation 2nd 176
Observation 3rd 177
Observation 4th 178
Lesions of texture produced by the Tartar Emetic . . . 180
Application of all that has been said to the different cases of poisoning by the Tartar Emetic 181
First Case.—The patient is living: the rest of the poison can be procured 182
Second Case.—The patient is living: the whole of the poison has been swallowed: the matter vomited can be procured 183
Third Case.—The patient is living: the whole of the poison has been swallowed: the matter vomited cannot be produced 184
Fourth Case.—The patient is dead . . . . . ibid.
Treatment of poisoning by the Antimoniated Tartrate of Potash 185
Of the Oxyde of Antimony, and the Glass of Antimony . 187
Of the Kermes Mineral and the Golden Sulphur of Antimony 188
Of the Muriate and Sub-muriate of Antimony 191
Of Antimoniated Wine 193
Observation 1st 195
Observation 2nd 196

Page
Of the other preparations of Antimony 196
Of Antimonial Vapours 197

Article 4th. Species 4th.

Poisons of Copper. . . . . ibid.
Of Copper 199
Of the Oxyde of Copper, and the Carbonate of Copper . 205
Chemical History of Verdegris 208
Action of Verdegris on the Animal Economy 213
Symptoms of Poisoning by Verdegris 218
Observation 1st . . . . . ibid.
Observation 2nd 219
Observation 3rd 220
Observation 4th 222
Observation 5th 223
Observation 6th 224
Observation 7th 225
Observation 8th . . . . . ibid.
Observation 9th . . . . . ibid.
Lesions of Texture produced by Verdegris 226
Application of all that has been said to the different cases of poisoning by Verdegris 227
First Case.—The patient is living: the rest of the poison can be acted upon . . . . . ibid.
Second Case.—The patient is living: the whole of the poison has been swallowed: the matter vomited can be acted upon 230
Third Case.—The patient is living: the whole of the poison has been swallowed: the matter vomited cannot be procured 233
Fourth Case.—The patient is dead . . . . . ibid.
Treatment of poisoning by Verdegris . . . . . ibid.
Of the Acetate of Copper: Crystals of Venus 241
Of the Sulphate of Copper 242
Of the Sulphate of Ammoniacal Copper 244
Of the Nitrate of Copper . . . . . ibid.
Of the Muriate of Copper 245

Page
Of Ammoniacal Copper 246
Of Coppery Wine and Vinegar 247
Of Coppery Soaps 248

ARTICLE V.

Species 5th.—*Preparations of Tin.*

Of Tin 247
Chemical History of the Muriate of Tin 250
Action of the Muriate of Tin upon the Animal Economy . 253
Symptoms of poisoning by the Muriate of Tin 258
Lesions of Texture produced by the Muriate of Tin . . . 259
Application of all that has been said to the different Cases of Poisoning by Muriate of Tin 260
Treatment of Poisoning by the Muriate of Tin 261

ARTICLE VI.

Species 6th.—*Preparations of Zinc.*

Var. 1st. Sulphate of Zinc 264
2nd. Oxyde of Zinc . . . . . ibid.
Of Zinc . . . . . ibid.
Chemical History of Sulphate of Zinc (white vitriol), . . 267
Action of Sulphate of Zinc upon the Animal Economy . . 268
Symptoms of Poisoning by the Sulphate of Zinc 271
Observation 1st . . . . . ibid.
Observation 2nd 272
Observation 3rd 274
Lesions of Texture produced by the Sulphate of Zinc . . ibid.
Application of all that has been said to the different Cases of Poisoning by the Sulphate of Zinc 275
Treatment of Poisoning produced by the Sulphate of Zinc, ibid.
Of the Oxyde of Zinc 276

ARTICLE VII.

Species 7th.—*Preparations of Silver.*

Var. Nitrate of Silver . . . . . ibid.

Page
Of Silver 276
Chemical History of the Nitrate of Silver 277
Of the Lapis Infernalis (Lunar Caustic) 279
Action of the Nitrate of Silver on the Animal Economy . 280
Symptoms of Poisoning produced by the Nitrate of Silver . 285
Lesions of Texture produced by the Ingestion of the Nitrate of Silver 286
Application of all that has been said to the different Cases of Poisoning by the Nitrate of Silver . . . . . ibid.
Treatment of Poisoning by the Nitrate of Silver 287

ARTICLE VIII.

SPECIES 8th.—*Preparations of Gold.*

Var. 1st. Muriate of Gold 290
2nd. Fulminating Gold . . . . . ibid.
Of Gold . . . . . ibid.
Chemical History of the Deuto-Muriate of Gold 291
Action of the Deuto-Muriate of Gold upon the Animal Economy 293
Symptoms and Lesions of Texture produced by the Deuto-Muriate of Gold 297
Application of all that has been said to the different Cases of Poisoning by the Deuto-Muriate of Gold . . . . . ibid.
Treatment of Poisoning produced by the Deuto-Muriate of Gold 298
Of Fulminating Gold . . . . . ibid.

ARTICLE IX.

SPECIES 9th.—*Preparations of Bismuth.*

Var. 1st. Nitrate of Bismuth 300
2nd. Subnitrate of Bismuth *(Blanc de fard)* . . . ibid.
Of Bismuth . . . . . ibid.
Chemical History of the Nitrate of Bismuth 301
Properties of the Solution . . . . . ibid.
Properties of the Subnitrate of Bismuth *(Blanc de fard)* . 303
Action of the Nitrate of Bismuth on the Animal Economy, ibid.

Page
Symptoms and Lesions of Texture produced by the Nitrate of Bismuth 307
Application of all that has been said to the different Cases of Poisoning by Nitrate of Bismuth . . . . . ibid.
Treatment of Poisoning by Nitrate or Subnitrate of Bismuth 309

ARTICLE X.

Species 10th.—*The Concentrated Acids.*

Varieties. The Sulphuric, Nitric, &c. &c. Acids . . . . ibid.
Of the Sulphuric Acid . . . . . ibid.
Chemical History of the Sulphuric Acid (Oil of Vitriol) . 310
Action of the Sulphuric Acid on the Animal Economy . . 314
Symptoms of Poisoning by the Sulphuric Acid 317
Observation 1st . . . . . ibid.
Observation 2nd 321
Observation 3rd . . . . . ibid.
Observation 4th 322
Lesions of Texture produced by the Sulphuric Acid . . 325
Application of all that has been said to the different Cases of Poisoning by Sulphuric Acid 327
Treatment of Poisoning by Sulphuric Acid 328
Of the Nitric Acid *(Aqua fortis)* 331
Physical and Chemical Properties of the Nitric Acid . . ibid.
Action of the Nitric Acid upon the Animal Economy . . 335
Symptoms of Poisoning by the Nitric Acid 337
Observation 1st . . . . . ibid.
Observation 2nd 339
Observation 3rd 341
Observation 4th 345
Observation 5th 347
Lesions of Texture produced by Nitric Acid 352
Application of all that has been said to the different Cases of Poisoning by Nitric Acid 354
First Case.—The Patient is dead: the Remainder of the Poison can be procured . . . . . ibid.

ARMY MEDICAL LIBRARY COLLECTION

Page

Second Case.—The Patient is living: all the Poison has been swallowed: Matter vomited can be procured 355
Third Case.—The Patient is living: the whole of the Poison has been swallowed: the Vomitings cannot be procured . 356
Fourth Case.—The patient is dead 357
Treatment of Poisoning by the Nitric Acid 358
Observation . . . . . ibid.
Physical Properties of Muriatic Acid 362
Action of the Muriatic Acid upon the Animal Economy . 365
Symptoms of Poisoning by the Muriatic Acid 366
Observation . . . . . ibid.
Lesions of Texture produced by the Muriatic Acid . . . 368
Application of all that has been said to the different cases of Poisoning by Muriatic Acid . . . . . ibid.
Treatment of Poisoning by the Muriatic Acid 369
Physical and Chemical Properties of the Phosphoric Acid . ibid.
Action of the Phosphoric Acid upon the Animal Economy, 371
Of some other Mineral and Vegetable Acids 372
Of the fluid Nitrous Acid . . . . . ibid.
Of the fluoric Acid 373
Of the Sulphureous Acid 374
Of the Phosphorous Acid 375
Of the Oxalic Acid . . . . . ibid.
Of the Tartaric Acid 376

ARTICLE XI.

Species 11th.—*Caustic or Carbonated Alkalies.*

Of Potash 377
Of the Lapis Infernalis 378
Sub-carbonate of Potash (Salt of Tartar) 379
Action of Potash upon the Animal Economy 380
Symptoms of Poisoning by the Caustic Potash 382
Lesions of Texture produced by Potash . . . . . ibid.
Application of all that has been said to the different Cases of Poisoning by Potash 383

Page
Treatment of Poisoning by Potash 383
Of Soda 385
Of Liquid Ammonia *(Alcali Volatil Fluor.)* . . . . . ibid.
Of the Sub-carbonate of Ammonia 387
Action of Ammonia upon the Animal Economy . . . . ibid.
Symptoms and Lesions of Texture produced by the fluid Ammonia 389
Application of all that has been said to the different Cases of Poisoning by Ammonia 391
Treatment of Poisoning by the fluid Ammonia . . . . ibid.

ARTICLE 12th.

Species 12th.—*Caustic Alkaline Earths.*

Of Barytes 391
Of the Carbonate of Barytes 392
Of the Muriate of Barytes 393
Action of the different Compounds of Barytes upon the Animal Economy 394
Of Barytes, and Carbonate of Barytes 398
Symptoms of Poisoning by Barytes 400
Application of all that has been said to the different Cases of Poisoning by Barytes and its Compounds . . . . . ibid.
Treatment of Poisoning by Barytes and its Compounds . . 402
Of Quick Lime 404
Action of Quick Lime upon the Animal Economy . . . 405
Symptoms and Lesions of Texture produced by Quick Lime, 406
Application of all that has been said to the different Cases of Poisoning by Lime . . . . . ibid.
Treatment of Poisoning by Lime 407

ARTICLE XIII.

Species 13th.—*Phosphorus.*

Physical and Chemical Properties of Phosphorus . . . . ibid.
Action of Phosphorus upon the Animal Economy . . . 409

Page
Symptoms and Lesions of Texture produced by Phosphorus, 415
Application of all that has been said to the different Cases of Poisoning by Phosphorus . . . . . ibid.
Treatment of Poisoning by Phosphorus 416

ARTICLE XIV.

Glass and Enamel in Powder 417
Facts which tend to prove the Innocence of Glass . . . 418
Accidents occasioned by Glass introduced into the Alimentary Canal 420

ARTICLE XV.

Species 15th.—*Cantharides* 423
Physical and Chemical Properties of Cantharides 424
Action of Cantharides upon the Animal Economy . . . 426
Symptoms of Poisoning by Cantharides 432
Observation 1st . . . . . ibid.
Observation 2nd 433
Observation 3rd 434
Observation 4th 435
Observation 5th 439
Observation 6th 440
Lesions of Texture produced by Cantharides 442
Application of all that has been said to the Poisoning by Cantharides . . . . . ibid.
Treatment of Poisoning by Cantharides 443

CHAP. II.—CLASS II.

ASTRINGENT POISONS.

ARTICLE I.—SPECIES I.

Page

The Compounds of Lead 444
Of the Acetate of Lead of Commerce *(Sugar of Lead)* . . 448
Of the Red Oxyde of Lead and Litharge 451
Of the Carbonate of Lead 454
Of Wines sweetened by Lead . . . . . ibid.
Of Water impregnated with Lead 455
Of Food cooked in Leaden Utensils . . . . . ibid.
Of Syrups and Spirits clarified with the Acetate of Lead . 456
Action of the different Compounds of Lead upon the Animal Economy . . . . . ibid.
Causes of the Symptoms produced by Saturnine Emanations, 457
Causes of the Symptoms produced by the injection of Saturnine Preparations into the Veins 459
Causes of the Symptoms produced by the Acetate of Lead introduced into the Stomach 461
Symptoms of Poisoning by Saturnine Preparations . . . 466
Observation 1st . . . . . ibid
Observation 2nd 467
Observation 3rd 468
Observation 4th 469
Observation 5th 471
Observation 6th 472
Lesions of Texture produced by Saturnine Preparations . 478
Application of all that has been said to the different Cases of Poisoning by Saturnine Preparations 480
First Case.—The Patient is living: the rest of the Poison can be procured . . . . . ibid.
Second Case.—All the Poison has been swallowed: the Matter vomited, and that found in the Digestive Canal after the Death of the Patient, can be acted upon 483

Page
Treatment of Poisoning by the Compounds of Lead . . . 484
Additions 493
Of Iode . . . . . ibid.
Action of Iode on the Animal Economy 495
On the Antidotes of Arsenic and Corrosive Sublimate . . 500
Super Oxygenated Muriate of Mercury 501
Arsenious Acid 502
Of Hydrogenated Sulphuret of Potash 511

A GENERAL SYSTEM OF TOXICOLOGY.

INTRODUCTION.

1. THE science, which relates to the investigation of poisons, has received the name of Toxicology, derived from the Greek words τοξικὸν *(poison)*, and λόγος *(a discourse)*.

2. The name of *poison* is given to any substance, which, taken inwardly in a very small dose, or applied in any kind of manner to a living body, depraves the health, or entirely destroys life.

3. It is not possible to investigate thoroughly any poisonous substance, without taking into consideration its relations with Chemistry, Natural History, Physiology, Pathology, and Morbid Anatomy. In short, how can we expect to distinguish the different poisons drawn from the mineral kingdom, without a knowledge of the chemical properties which characterize them in their natural state; or when that state has been destroyed by their combination with aliments, whether vegetable or animal? Are we not indebted to Natural History for the exclusive privilege of becoming acquainted with the immense

series of poisons from the *organic* kingdom, which unfortunately elude the most rigorous analytical research? Can the corrosive or narcotic effects of these mischievous substances, which derange the different functions of the Animal Economy, after having destroyed the harmony of the powers of life, be explained without the light of the soundest Physiology? Is it not the province of Pathology to attend carefully to the treatment of the diseases originating from poisons, whether in using means already known, or in seeking out new remedies capable of destroying or annihilating their deleterious effects? Lastly, is it not by Morbid Anatomy that the knowledge of these substances is brought to perfection, which makes us acquainted, by examination of the different organs, with the multiplied injuries resulting from their action? There remains no doubt of the necessity of having recourse to each of these sciences, and to interrogate them at first separately, to be able the better afterwards to lay hold on their mutual dependencies, and the resources they are capable of affording.

4. Chemical researches, carefully conducted on the different poisons of the mineral kingdom; an attentive observation of the characters furnished by the various poisons of the organized creation; experiments made upon living animals, with the design of ascertaining the derangement of their functions, and the varied causes of a dissolution so sudden; clinical facts, collected with exactness, and enriched by dissections; in fine, trials made on living animals, in order to fix our ideas with respect to counter-poisons: these are the only means to enrich the science of Toxicology, and to raise it from the state of imperfection in which it at present lies. The utility of this mode of proceeding has been felt by learned men; in consequence of which we have, for some time past, witnessed the appearance of several excellent successive treatises on *Arsenic*, *Corrosive Sublimate*, Copper, Nitric, and Prussic Acids, &c. These tracts are, unfortunately, very few in number, and the objects are not considered in them under all their

relations. The chemical part, and that part of medical jurisprudence which relates to poisoning, are particularly neglected. We have observed, for the most part, that these authors have selected the least prominent features of the poisonous substances, exposed them often in an erroneous manner, and, consequently, rendered the resolution of a problem extremely difficult of itself, and which possesses the greatest interest, impossible. In vain does the professor of Medical Jurisprudence, when called upon by the magistrate, look to their writings; all he can extract from them is vague and unsatisfactory.

It may hence be seen how important it is to pay particular attention to this part of Toxicology, in order to get rid of a multitude of characteristics of little value, to rectify those badly described, and substitute in their stead others, exact, and easy to be ascertained.* Such an undertaking presents the greatest difficulties, as well from the prodigious number of poisons which it must necessarily embrace, as from the various decompositions which many of them are capable of undergoing. It must be confessed, that this science, already very complicated by its numberless relations with Physiology, Pathology, and Morbid Anatomy, is rendered more difficult by this branch of Medical Jurisprudence. It is only by adopting a rigorous method in the exposition of facts, carefully collected, retrenching all explications found to be inconsistent with sound logic, that we can hope to surmount, with greater ease, the obstacles which this study presents.

* The inestimable Author of the Medico-Legal Consultations, printed in 1811, has pointed out the method of recognizing Corrosive Sublimate, in which he has far excelled all that have gone before him. His labours have presented profound views of the subject, of which I have greatly availed myself, and gladly render him my acknowledgements. Since, however, many of the experiments pointed out by this illustrious Professor, have been found not to agree with those I have often made on the same subject, I shall take the liberty of making some remarks on the proceedings he advises.

5. Can any real advantage be obtained to the study of Toxicology by a classification of the poisons already known? Or would it be better to describe them in alphabetical order? This question I have often heard agitated. I do not hesitate a moment in deciding in favour of the classification, especially when founded upon incontrovertible physiological facts; there is then no doubt that it simplifies the study of this science. In bringing together into one group those poisons which exercise a similar action on the animal economy; in describing accurately all the alterations they produce on our organs, and consequently on our functions; in one word, by generalizing the symptoms to which they give rise, it may be perceived how much the particular history of each may be the easier laid hold of by the Pathologist. On the contrary, of what use to the man of science can be a description alphabetically arranged? The separation of substances which ought to be united in consequence of their intimate connexion with each other, together with tedious repetitions in the details, are the inconveniences attached to this unscientific method, of which every correct mind perceives the defect.

6. Amongst the classifications hitherto proposed, we give the preference to that published by M. Fodéré, in the fourth volume of his *Médecine Légale* (2nd edition). It appears to us the most natural, and the most conformable to the ideas of Physiology. It is not, however, altogether unobjectionable; and it may be expected that some of these poisonous substances will pass from one class into another, in proportion as the progress of physiological knowledge elucidates their modes of action. This author arranges all poisons under six classes. The first of which includes the septic, or putrefying poisons; the second, the stupifying, or narcotic substances; the third, the narcotico-acrid; the fourth, the acrid; the fifth, the corrosive, or escharotic; lastly, the sixth, the astringent. We shall now present a general table of all the poisons, beginning by the corrosives, the study of which appears to us the most important.

CLASS I.

CORROSIVE, OR, ESCHAROTIC POISONS.

SPECIES I. *Mercurial Preparations.*

Var. 1st. Corrosive sublimate, or muriate of mercury at the maximum of oxydation.

2nd. Red oxyde of mercury (precipitate *per se*, red precipitate).

3d. Turbith mineral, or sulphate of mercury at maximum with excess of base.

4th. The nitrates of mercury at maximum, at minimum, acid, or with excess of base.

5th. All the other preparations of mercury, except mercur. dulc. (calomel).

6th. Mercurial vapours, and mercury extremely divided.

SPEC. II. *Arsenical Preparations.*

Var. 1st. Arsenious acid, or white oxyde of arsenic.

2nd. Arsenites, or combinations of that acid with salifiable bases.

3d. Arsenic acid.

4th. Arseniates, or combinations of arsenic acids with the bases.

5th. Sulphuret of arsenic, yellow.

6th. ——————————, red.

7th. Black oxyde of arsenic, fly powder.

SPEC. III. *Antimonial Preparations.*

Var. 1st. Tartar emetic, or antimoniated tartrate of potash.

2nd. Oxyde of antimony; whether by calcination or by decomposition of nitric acid.

3d. Kermes mineral, golden sulphur of antimony, beyond the medical doses.

4th. Muriate, and sub-muriate of antimony.

Var. 5th. Antimonial wine.
6th. Other antimonial preparations.

SPEC. IV. *Preparations of Copper.*

Var. 1st. Verdegris.
2nd. Acetate of copper, Crystals of Venus.
3d. Sulphate of copper, blue vitriol.
4th. Nitrate of copper.
5th. Muriate of copper.
6th. Ammoniacal copper.
7th. Oxyde of copper.
8th. Coppery *savonnules*, or copper dissolved by grease.
9th. Coppery wine and vinegar.

SPEC. V. *Preparations of Tin.*

Var. Muriate of tin.

SPEC. VI. *Preparations of Zinc.*

Var. 1st. Oxyde of zinc sublimated.
2nd. Sulphate of zinc, white vitriol.

SPEC. VII. *Preparations of Silver.*

Var. Nitrate of silver.

SPEC. VIII. *Preparations of Gold.*

Var. Muriate of Gold.

SPEC. IX. *Preparations of Bismuth.*

Var. 1st. *Blanc de fard*, or sub-nitrate of bismuth.
2nd. The other preparations of bismuth.

SPEC. X. *The concentrated acids, sulphuric, nitric, phosphoric, muriatic, &c.*

SPEC. XI. *The Caustic Alkalies; pure or carbonated.*
Var. 1st. Potash.
2nd. Soda.
3d. Ammonia.

SPEC. XII. *Caustic alkaline earths, lime, barytes.*
XIII. *Muriate and carbonate of barytes.*
XIV. *Glass and enamel, in powder.*
XV. *Cantharides.*

CLASS II.

ASTRINGENT POISONS.

SPECIES I. *Preparations of Lead.*

Var. 1st. Acetate of lead, or *Saccharum Saturnii.*
2nd. Carbonate, red oxyde of lead, and litharge.
3rd. Cerussa.
4th. Wine sweetened by lead.
5th. Water impregnated with lead.
6th. Provisions cooked in vessels containing lead.
7th. Syrups and brandy clarified with acetate of lead.
8th. Saturnine emanations.

CLASS III.

ACRID POISONS.

SPECIES 1st. Oxygenated muriatic gas; simple muriatic gas; sulphureous and nitrous acid; nitro-muriatic acid.
——— 2nd. Jatropa Manihot. The fresh root and juice of the Manihot, or Manioc.
——— 3d. Indian ricine, or Molucca wood.
——— 4th. Convolvolus scammonia, scammony.
——— 5th. Gum gutta.

Species 6th. Seeds of Ricine, or Palma Christa, in the dose of from four to fifty grains.

——— 7th. The inspissated milk of the *Concombre d'âne sauvage*, or Elaterium.

——— 8th. The apple of the Colocynth.

——— 9th. The whole plant, and especially the root of white Hellebore.

——— 10th. The root of black Hellebore.

——— 11th. The seeds of Stavesacre and of Caustic Barley.

——— 12th. The wood and fruit of the "Ahovai," of Brazil and of the Indies.

——— 13th. All the plant of the Rhododendron Chrysantum.

——— 14th. The bulbs of the Colchicum, gathered in summer and in autumn.

——— 15th. The milk of the Convolvolus Arvensis, or little Bindweed.

——— 16th. The whole of the plant of the Swallow Wort, and *Fly-Catcher*, with herbaceous flowers.

——— 17th. The whole plant of the hairy Asclepias, and the Asclepias Vincetoxicum.

——— 18th. The Ænanthe Fistulosa, Water Dropwort.

——— 19th. The Ænanthe Crocata.

[These two species are poisons equally violent for dogs and cattle, especially their roots.]

——— 20th. The Clematis, broad-leaved.

———————, creeping.

———————, strait.

———————, flaming. The whole plant.

——— 21st. The whole plant of the *Anemone Pulsatilla.*

——————————— Anemone of the woods, and that with yellow flowers.

——— 22nd. The Marsh Marigold.

——— 23d. Sometimes the old roots of Parsnips.

SPECIES 24th. The root of the Aconitum Napellus.
——— Aconite (*Wolf's bane*).
——— 25th. The fresh roots of the spotted Arum.
——— 26th. The berries and the bark of the Daphne Mezereon; and, in general, all the varieties of the Spurge Laurel.
——— 27th. The whole plant, as well as the emanations of the Rhus-toxicodendron, and of the Rhusvernix, or *Rhoux*.
——— 28th. The whole plant of the Euphorbium Officinale, and of all the species and varieties of that family, as well as the *Tithymali*.
——— 29th. The whole plant of the *Ranunculus* of meadows, gardens, mountains, and marshes. This last particularly (called Sceleratus) is the most poisonous of the whole. In general, all the *Ranunculi* are more or less poisonous, even to cattle.
——— 30th. The Nitrate of Potash, in a large dose, sometimes.
——— 31st. Muscles, and other shell-fish, sometimes.

CLASS IV.

STUPIFYING OR NARCOTIC POISONS.

SPECIES 1st. Pure Hydrogen Gas; Azotic Gas; Gaseous Oxyde of Azote.
——— 2nd. White Oriental Poppy, the white or party-coloured Poppy of the gardens of Europe, and the opium prepared from them.
——— 3d. The roots of the Physalis Somnifera, or Solanum Somniferum, Alkekenge, or *Coqueret*.
——— 4th. The berries and leaves of the "Solanum Nigrum," or deadly Night-shade.

SPECIES 5th. Those of the Nightshade with yellow fruit.
——— 6th. The roots and leaves of the Atropa Mandragora, or Mandragore.
——— 7th. The stalks, leaves, and fruit of the Datura Stramonium, or Thorn Apple.
——— 8th. The whole plant of the Henbane, both of the black and white, which last is always less strong than the black.
——— 9th. The whole plant of the Lactuca Virosa, or strong-scented Lettuce, and of the wild prickly Lettuce.
——— 10th. The whole plant and berries of the Paris Quadrifolia, or Fox Grape.
——— 11th. The whole plant of the Laurel.
——— 12th. The berries of the Yew.
——— 13th. The seeds of the Fitch, or Vetch.
——— 14th. The seeds of the Lathyrus Cicera, a sort of Vetch.
——— 15th. The distilled water of Black Cherry-stones, when concentrated, and that of Peach-stones; and, perhaps, likewise, of their leaves, when these waters are concentrated.
——— 16th. The effluvia, or emanations from these plants, or their *Aroma*.

CLASS V.

NARCOTICO-ACRID POISONS.

SPECIES 1st. Carbonic Acid Gas; the gas exhaling from lime-kilns.
——— 2nd. The Manchineal Apple and Tree.
——— 3d. The Bean of St. Ignatius.
——— 4th. The exhalations and juice of every part of the tree called the Poison Tree of Macassar.
——— 5th. The *Ticunas*.

ARMY MEDICAL CEYLON

SPECIES 6th. Certain species of the Strychnos (Nux Vomica).

——— 7th. The whole plant of the Rose-Laurel.

——— 8th. The leaves and berries of the Belladonna.

——— 9th. The Nicotiana, or Tobacco.

——— 10th. The Nicotiana Glutinosa.

——— 11th. The roots of white Bryony, with berries, red or black.

——— 12th. The roots of the wild Chervil.

——— 13th. The whole plant of the Conium Maculatum, or Great stinking Hemlock.

——— 14th. The roots and herb of the lesser Hemlock, or Parsley-shaped *Æthusa*.

——— 15th. The roots of the Cicuta Aquatica.

——— 16th. The Anagallis Arvensis.

——— 17th. The Mercurialis Perennis, or Mountain Mercury.

——— 18th. The Digitalis Purpurea.

——— 19th. The distilled waters of these different plants concentrated, and their essential ethereal empyreumatic oils.

——— 20th. The odorous principle of all these plants, and the same odours of different flowers and fruits, although pleasant, shut up in a close room.

——— 21st. Ergotted Rye and Darnel.

——— 22nd. Wheat, Barley, Oats, &c. when musty, rotten, or mildewed, often.

——— 23d. The Potatoe, *Solanum Tuberosum*, sometimes.

——— 24th. The Apple of Love, *Solanum Lycopersicum*, sometimes.

——— 25th. "Solanum Melongena," sometimes.

——— 26th. The Puff-ball, truffle.

——— 27th. Bad Mushrooms.

CLASS VI.

SEPTIC, OR PUTREFYING POISONS.

SPECIES 1st. Contagious Miasmata, emanating from pestiferous bodies, or bales of merchandize coming from a place infected with the plague.

Idem. Emanations from a confined space, where a number of persons are shut up, receiving the air only through small apertures.

Idem. Emanations from living bodies attacked by putrid fevers, or with large wounds in a state of suppuration, or gangrene, scurvy, or dysentery.

SPECIES 2d. Exhalations from burying-grounds, hospitals, prisons, ships, privies, marshes, putrid vegetables, and stagnant water.

——— 3d. Sulphurated Hydrogen Gas.

——— 4th. The poison of the Viper, and certain reptiles.

SECTION I.

OF POISONS IN PARTICULAR, THEIR CHEMICAL PROPERTIES, THEIR PHYSIOLOGICAL ACTION, THE SYMPTOMS TO WHICH THEY GIVE RISE, THE LESIONS OF TEXTURE THEY PRODUCE, AND THE TREATMENT OF POISONED PERSONS.

CHAP. I.

CLASS I. OF CORROSIVE POISONS.

7. Corrosive poisons, are so called, because, in the general way, they irritate, inflame, and corrode the texture of the parts with which they come in contact. The energy with which they produce all these effects, varies remarkably, according to the dose in which they are taken, and as they may be in a liquid or solid form; and, lastly, as they may have been administered internally, or applied externally.

In general their action is more brisk and formidable than that of other poisons.

All the acids, and all the alkalies, almost all metallic preparations, many earthy and alkaline salts, cantharides, &c. form a part of this important class. We shall first consider all that can be said of them generally, before entering upon a particular examination of them.

THE GENERAL ACTION OF CORROSIVE POISONS.

8. Whenever the smallest quantity of any of these bodies is employed internally, various changes may be observed to take place in the exercise of the functions. At one time they produce a temporary, or durable, excitement of the brain and of the heart; at another, they act as sedatives on these organs; very often they increase the customary secretions; sometimes, on the contrary, they diminish them. The therapeutic art has taken advantage of these different modes of action, and we see every day enlightened practitioners administer with impunity these deleterious substances, and reap the greatest advantages from them.

Given in larger doses they are productive of horrible accidents, followed very often by a sudden and terrific dissolution, the immediate cause of which is not always the same. In certain cases, the poison is absorbed, and carries its fatal action to the brain, the heart, and other organs. In some instances it is the corroded membranes of the stomach which act by sympathy on these organs, and suspend their functions, without any absorption taking place. Lastly, in other circumstances, which very rarely occur, death is the consequence of inflammation of the stomach, irritated by these poisonous substances. We purpose investigating this subject in detail, by treating particularly of each of these poisons.

GENERAL SYMPTOMS PRODUCED BY THE CORROSIVE POISONS.

9. The general symptoms produced by these corrosive substances, depend almost all upon the lesions of the alimentary canal, of the nervous system, and of the organs of the circulation; which ideas are perfectly consonant with the general physiological notions we have just laid down. These symp-

toms are, a heat and constriction of the mouth, tongue, œsophagus, stomach, and intestines; excruciating pains throughout the whole extent of the alimentary canal, principally in the stomach and œsophagus; singultus, frequent nausea, painful and obstinate vomitings, sometimes accompanied with blood, and which threaten suffocation; bloody stools, with or without tenesmus; pulse small, hard, and frequent, often imperceptible, with an icy coldness. Sometimes, however, the heat is intense the thirst inextinguishable, dysuria, strangury, ischuria, and cold sweat. Purple spots over the whole body, and often a miliary eruption. A sudden decomposition of the features of the countenance ensues, loss of sight, risus sardonicus, convulsions, and horrible contortions, with depravation of the intellectual faculties.

LESIONS OF TEXTURE PRODUCED BY THE CORROSIVE POISONS.

10. Amongst the secondary means to which the Professor of Medical Jurisprudence has recourse, with the greatest success, to substantiate the act of poisoning, the anatomical inspection of the body necessarily occupies the first place. In general, all those who have fallen victims to this kind of disease, exhibit in their contexture alterations more or less considerable, and which vary according to the nature of the poison administered, and the time which it has had to produce its effects. The corrosive poisons, which form the subject of these general investigations, frequently leave behind traces of their passage over our organs, and it is of importance to know them thoroughly.

1st. Inflammation of the first passages, constrictions of the intestinal canal, gangrene, sphacelus, perforation of these parts, constitute the first character of these kinds of lesions. We could bring forward, in support of this proposition, the results of dissections of a number of animals which we have poisoned

with different substances of this nature. We shall, however, confine ourselves to the details of two dissections made by Hoffman and M. Tartra. The first of these authors says,* that a man of twenty-six years of age was poisoned by some soup containing arsenious acid. He died thirty hours after. The stomach was found inflamed near its left orifice, the mucous membrane abraded and destroyed; the intestines partly gangrenous, and in some measure twisted and curled up. M. Tartra details the history of a woman poisoned by the nitric acid (*aqua fortis*), and whose death happened not till four-and-twenty hours after having taken the poison. The symptoms preceding it denoted already a gangrene in some portion of the digestive canal. On dissection three openings were discovered at the bottom of the great extremity of the stomach, near to one another, of the size of a half-crown piece, with edges extremely thin, and worn, or rather dissolved. It was very thick and exceedingly shrivelled over all the rest of its surface. The orifice of the pylorus exhibited several gangrenous spots. The duodenum was attacked with gangrene at its two curvatures and throughout the whole thickness of its coats.†

2nd. The mucous coat detaches itself easily from the muscular, in such manner that it and the serous coat remain perfectly isolated. Hebenstreit and Mahon regard this appearance as an infallible proof of poison. The latter of these authors observes, "I believe, even with Hebenstreit, that the "most infallible sign of poison, is the separation of the villous "coat of the stomach.

"In short, if we suppose a person officially called upon to "examine the body of a man who has died after a vomiting "of blood, accompanied with other suspicious symptoms, it "is evident, that if this vomiting proceeds from any internal

* Friderici Hoffmanni Op. Omnia Physico-Medica, tom. iii. sect. ii. cap. viii. Observatio iii. p. 171.

† Dissert. Inaugural. Essaie sur l'Empoisonnement par l'Acide Nitrique.

" or natural cause, no other traces of lesion will be found in " the stomach, than the blood-vessels dilated, or burst, ap- " pearances of inflammation, gangrenous spots, &c. But if " the interior surface of this viscus be found as it were " flayed, if fragments of its villous coat should be met with " amongst the matter contained in it, it seems natural enough " to conclude, that such a separation could only have taken " place from the introduction of some burning or corrosive " substance into the cavity of the stomach. It is hardly pos- " sible to suppose that putrefaction alone could produce upon " this villous surface, the same effects as it produces upon the " *epidermis* of the dead body; since the rugosities or folds of " this interior coat of the stomach do not admit of so sudden " a separation: moreover, in the course of a very frequent " examination of the human stomach, I have never met with " an instance of the villous coat, separated by putrefaction, " even when this putrefaction was very considerably advanced " in all parts of it. These observations, confirmed by those " of Hebenstreit, appear to me to warrant the person em- " ployed to conduct the investigation, to look upon this sign " as the most positive; although on the other hand, it is pos- " sible to conceive, that on the crisis of certain atrabiliary " diseases, those who have been long afflicted with the *morbus* " *niger*, may sometimes be in a situation to present appear- " ances analogous to the above. If, however, this circum- " stance (which is very rarely met with) should occur, the ex- " istence of the atrabiliary affection might be proved, either " by the vestiges of it which would be found in the stomach, " or by taking into consideration the temperament of the pa- " tient, and his antecedent diseases." *

3dly. Frequently the corrosive action of these poisons is extended to the other viscera, and the skin becomes covered with black spots, resembling gangrene. Morgagni makes mention of

* Mahon, Médecine Légale, l. ii. p. 289.

a woman poisoned with arsenic, whose body, after death, was entirely black on its posterior surface, from head to foot; the lungs were gangrenous, and the stomach and duodenum eaten through.*

11. The characters which we have just been describing are however sometimes wanting in cases of poison by corrosive substances, and the dead body exhibits no alterations. When we shall have occasion to treat, in the last section of this work, on the duties of a medical man in a legal capacity, when called upon by the magistrate, we shall point out the line of conduct which he ought to observe in these cases rarely free from difficulties. We shall likewise defer to that section the exposition of the general rules to be observed for conducting properly the dissection of the dead bodies of poisoned persons.

GENERAL TREATMENT OF PERSONS POISONED BY CORROSIVE SUBSTANCES.

12. The practitioners employed in this branch of the healing art, have adopted various methods to counteract the mischief produced by corrosive poisons. At one time, blinded by the results of chemical operations performed in their laboratories, they have extolled a multitude of substances which ought to decompose these poisons in the stomach, and consequently prevent their fatal effects. At another time, rejecting this mode of proceeding, they have been contented to administer, in the first instance, evacuating medicines, strong or mild, according to circumstances; with the intention of having recourse afterwards to anodynes, antiphlogistics, antispasmodics, &c. To evacuate the poison, and to relieve the symptoms which have already appeared, has been the end which they have proposed to themselves to attain. And finally, there have been

* De Causis et Sedibus Morborum, Ep. LIX. art. iii. p. 244.

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others who have combined in their treatment all the means we have just described.

The first of these, confining themselves to the use of antidotes, have run into serious errors. Many of the substances which they have given for the purpose of decomposing these poisons, have exerted no action whatever upon them in the stomach; and not unfrequently, when the decomposition has been effected, the new compound has been found to be endued with the most active poisonous qualities. We shall report, in order, experiments which will leave no doubt on this subject, and enable us to set a just value on these antidotes.

The evacuant, antiphlogistic, and antispasmodic method, wisely employed in these days by our best physicians, appears to us to merit the preference to all others. Without exposing the patient to the danger to which a chemical decomposition might subject him, it offers the double advantage of getting rid of the poison by simple means within the reach of every body, and at the same time of re-establishing the functions in their natural state.

ARTICLE I.

Species I. *Mercurial Poisons.*

Var. 1st. Corrosive sublimate, or muriate of mercury at the maximum of oxydation.

2d. Red oxyde of mercury, (precipitate *per se*, red precipitate).

3d. Turbith mineral, (sub-deuto-sulphate of mercury).

4th. The nitrates of mercury at maximum, at minimum, acid, or with excess of base.

5th. All the other mercurial preparations, except the mercurius dulcis.

6th. Mercurial vapours, or mercury extremely divided.

13th. The study of mercurial poisons demands, on the part of the physician, the most scrupulous attention. Every day's experience confirms the greatness of the advantages to be derived from them by the man of science, who understands correctly their mode of acting; whilst the empiric, on the other hand, furnishes us with too many irrefragable evidences of their deleterious effect. Without the slightest knowledge of the nature of these bodies, or of their powerful and instantaneous action on the animal economy; without the least regard to the constitution of the patients, whose confidence he has usurped; pretending even that there is no danger whatever in the exhibition of these substances, he dares to introduce into our organs tremendous doses of mercurial preparations, which never fail to produce the most fatal effects, as we shall have occasion to notice when treating of slow poisoning.—A profound attention to these substances can alone serve to direct us in the use which should be made of them.

14. It is more particularly important, that the juridical physician should be perfectly acquainted with the properties of the preparations which form the subject of this article. Almost all vegetable and animal substances, our organs themselves change and decompose In vain should we seek, in general, for corrosive sublimate in the liquids vomited; neither are the contents of the stomach more calculated to discover its presence. The decomposition which it has undergone by its union with other substances, has rendered it insoluble. It is in the solids, in the texture itself of our organs, that it must be sought for. It is only by rigorous scrutiny, founded upon sure chemical principles, that we can hope to find it. Such being the case, does it not become indispensably necessary to determine, what are the changes which the aliments most commonly employed, effect in these poisonous substances, and consequently, ought we not to commence their history by a complete investigation of their chemical properties?

CHEMICAL HISTORY OF MERCURIAL POISONS.

Before entering upon the chemical properties of mercurial poisons, it will be proper to establish some fixed notions concerning metallic mercury and calomel. These notions will be of the utmost utility to us in explaining the complex phenomena of which we shall have afterwards to treat.

OF MERCURY.

15. Mercury is a liquid metal, shining, of a white colour, slightly inclining to blue. Its specific gravity is 13,568. On being heated, it becomes volatile. At the temperature of 350° (th. c.) it enters on ebullition in such manner, that the fixed bodies with which it is sometimes found united, can easily be separated from it.

16. Mercury combines with sulphur, and forms sulphurets of a black or red colour, in which the proportions of sulphur and of mercury are not the same. This metal, by various processes, can be combined with oxygen, and gives birth to two oxydes; one of a blackish gray, at the minimum of oxydation; the other yellow or red, at the maximum. We shall proceed to explain some of the properties of these two oxydes.

A. They part easily with their oxygen, when submitted to the action of a temperature a little elevated.

B. The black oxyde, saturated by the muriatic acid, constitutes the *mercurius dulcis* (*calomel*), or muriate at minimum, of a white colour, and insoluble in water. On the contrary, the yellow oxyde, saturated by this same acid, forms the corrosive sublimate, or muriate at maximum, soluble in water.

C. The black oxyde dissolves in the cold in pure and diluted nitric acid, and produces nitrate at minimum; this nitrate falls in a white precipitate on the addition of the muriatic acid, which transforms it into *mercurius dulcis*, in a blackish gray by potash, or ammonia, which separate the oxyde from it, and

in a red by the chromic acid, or by the chromate of potash, which change it into a chromate of mercury insoluble. On the contrary, the oxyde at maximum, being dissolved in the nitric acid, gives a solution which is not precipitated either by the muriatic or chromic acid, and from which potash separates a yellow oxyde. With metallic mercury, and nitric acid, these two nitrates can be easily procured. If nitric acid be employed at 16° or 20°, and made to act upon this metal without heat, nitrate at minimum will be obtained: if the acid be concentrated, and its temperature a little raised, nitrate at maximum will be produced.

D. Both of these two nitrates furnish a black precipitate by means of the hydro-sulphurets of potash, or of ammonia. This precipitate is composed of sulphur and mercury.

17. *Rationale.* The hydrogen of the hydro-sulphuret seizes upon the oxygen contained in the oxyde of mercury, and forms water. At the same time the sulphur and the metal being presented naked to each other, unite and form an insoluble sulphuret; whilst the nitric acid combines with the base of the decomposed hydro-sulphuret.

Whatever we have to say further respecting the poisonous properties of this metal, will be referred to the article "Mercurial Vapors."

OF MERCURIUS DULCIS.

18. The mercurius dulcis, or muriate of mercury at minimum, is formed by the muriatic acid, and the oxyde at minimum. It is white; but it becomes blackish by a long exposure to the light. On being heated, it sublimes and furnishes crystals, consisting of tetraedral prisms terminated by four-sided pyramids.

19. If a paste be made with this salt, of charcoal and a little water, and exposed to the action of caloric in close vessels, there will be obtained, metallic mercury, carbonic acid gas, muriaticacid gas, and oxygen gas.

Rationale. The charcoal, by reason of the elevation of temperature, and its strong affinity for oxygen, seizes that which is contained in the oxyde of mercury, and forms carbonic acid gas; then the metallic mercury and the muriatic acid, which result from this decomposition, not being capable of remaining longer united,* and being susceptible of volatilization, become disengaged. This fact, which was first noticed by M. Boullay,† is one of those which is of the utmost importance to be known in the researches of medical jurisprudence on the poisoning by mercurial preparations.

20. Water dissolves so small a quantity of this salt, that it is looked upon justly as extremely insoluble.

21. When reduced to a fine powder, and boiled in distilled water, to which has been added alcoholized potash,‡ it is observed to become black immediately, and is entirely decomposed after a few moments of ebullition. The fluid filtered contains muriate of potash, and oxyde of mercury at minimum remains on the filter. The potash effects this decomposition by virtue of its affinity for the muriatic acid, which is stronger than that of this acid for the oxyde of mercury.

In order to be assured that the liquid contains muriatic acid, nitrate of silver in solution should be poured upon it: an abundant precipitate is instantly formed of a pale gray colour. This precipitate is composed of the oxyde and the muriate of silver;§ for if heated by the pure nutric acid, the

* Metals can only combine with acids whilst in a state of oxydation.

† Annales de Chymie, an. 1802.

‡ 'Potasse à l'alcohol.'

§ The formation of muriate of silver takes place here by virtue of a general rule, of the importance of which we cannot be too sensible for the resolving of several problems in medical jurisprudence. Every time that two salts in a state of solution are brought together (*ex. nitrate of silver and muriate of potash*), which salts contain within themselves, elements capable of producing a soluble salt (*nitrate of potash*), and an insoluble salt (*nitrate of silver*), the decomposition must necessarily take place. It is easy to conceive, that by the help of this rule (for which we are indebted to the ce-

whole of the oxyde will be dissolved, and the muriate of silver remain at the bottom of the vessel. This muriate, which is extremely heavy, curdled, insoluble in water, and in nitric acid, soluble in the liquor of ammonia, and capable of becoming black by the contact of light, leaves no doubt of the presence of muriatic acid. It is evident that this acid can only belong to the mercurius dulcis, since neither the distilled water, nor the alcoholized potash contain any.

As to the black oxyde of mercury remaining upon the filter, it is easy to be recognized, by causing it to be dissolved in the diluted pure nitric acid, and precipitating the solution by the re-agents pointed out, § 17. C.

22. The muriate of mercury at minimum, in a solid state, exerts a remarkable action on the caustic potash.

EXPERIMENT.—Begin by procuring a small glass tube, open at one end, and closed at the other. (*See fig.* 1.) It ought to be about 10 inches long, and 4 or 5 lines in diameter, and in thickness about a quarter of a line. If a mixture composed of equal parts of caustic alcoholized potash and of mercurius dulcis be introduced to the bottom of this instrument, and exposed to the action of a gradual heat, so as not to break the glass, the potash soon begins to melt, the mixture acquires a gray colour, and if the heat is continued for five or six minutes, metallic mercury will be obtained in small globules adhering to the internal surface of the tube, together with oxygen gas which becomes liberated, and muriate of potash, which occupies the bottom of the instrument, mixed with the superfluity of the potash employed.

Rationale. The potash seizes upon the muriatic acid of the muriate at minimum, and forms fixed muriate of potash: the black oxyde of mercury being exposed naked, and being

lebrated author of the Statique Chimique), and the simple knowledge of the solubility and insolubility of the salts, a great number of decompositions may be explained.

capable of decomposition by the simple action of caloric, is transformed into mercury and oxygen gas, which fly off.

23. The hydro-sulphurets blacken the mercurius dulcis, because they transform it into a black sulphuret of mercury.

CHEMICAL HISTORY OF CORROSIVE SUBLIMATE.

24. Corrosive sublimate is a metallic acid salt, formed of muriatic acid, and oxyde of mercury at the maximum of oxydation. That which is met with in commerce, generally contains muriate of iron. This salt is likewise known by the names of "muriate of mercury at the maximum of oxydation," of "oxymuriate of mercury," of "superoxygenated muriate of mercury," and of "muriate of the second oxyde of mercury," or "deuto-muriate of mercury." *

25. The corrosive sublimate of commerce is found under various forms, according to the manner of preparing it. If it has been obtained by sublimation, and the operation has been slowly conducted, it will be in the form of regular, compressed, slender, tetraedric prisms. If the sublimation has not been carefully attended to, it will be in the form of white masses, compact, semi-transparent on their edges, hemispherical and concave; their external surfaces polished and shining; their internal surface is unequal, with a projection of small brilliant crystals, so compressed that their sides cannot be distinguished. Authors have compared them to the beard of a feather, or the blade of a knife or poniard. When corrosive sublimate has been crystallized, by evaporating the water in which it was dissolved, it presents small sharp-pointed bundles, extremely distinct, which, according to Fourcroy, are oblique

* Of all these denominations, the last one only has the merit of expressing concisely the nature of the compound in question, which renders it preferable to all the rest. As to that of the super-oxygenated muriate of mercury it is essentially bad, since it conveys the idea of a combination of super-oxygenated muriatic acid and the oxyde of mercury.

parallelopìpèdes. Sometimes, also, it crystallizes in cubes, or in hexaedric prisms, extremely regular, or in quadrangular prisms, with their sides alternately narrow and broad, terminated by cuneiform summits, and presenting two inclined planes.

26. Corrosive sublimate has a taste peculiarly acrid and caustic; it occasions a sensation of metallic astringency, very powerful, and very disagreeable; and a kind of tightness of the throat, which continues for some time. Its specific gravity is very considerable. Muschenbröeck states it as high as 8,000, but by more recent experiments it has been ascertained to be 5,1398.*

27. The deuto-muriate of mercury, pounded in a mortar of glass or agate, and exposed on burning coals, is immediately volatilized, giving out a thick white smoke, of a very pungent smell, not at all resembling garlic, which irritates the nose, seizes on the throat, and often excites coughing. A plate of copper, perfectly cleared from verdigrise, exposed to this smoke, appears tarnished, and receives, by a slight friction, that white and glittering colour which characterizes mercury.† A piece of paper of Tournesol, submitted to the action of this vapour becomes red, in consequence of the excess of acid contained in the volatilized salt.

28. Corrosive sublimate, exposed to the air, loses a portion of its transparency, and becomes white, opake, and pulverulent on its surface.

29. If a paste, formed of charcoal, corrosive sublimate, and a little water, be submitted to the action of caloric, metallic mercury is obtained, with carbonic acid, muriatic acid, and oxygen. The rationale is the same as we have explained above, in speaking of the mercurius dulcis. (§ 19.)

* A System of Chemistry, by J. Murray, 2nd edition, vol. iii. Quicksilver or mercury.

† A plate of copper is easily freed from its verdigrise by plunging it into sulphuric or nitric acid; or, what is better, by rubbing it with freestone, or a fine file.

30. If corrosive sublimate be let fall in minute fragments into a tube of glass, (*fig.* 1.) the bottom of which contains a little caustic potash melted and perfectly pure, it will be seen, that one portion of this salt escapes the action of the potash, and rises in the form of smoke, to condense itself on the sides of the tube; another portion sinks down, unites with the potash, and takes a red colour. If the heat be continued for five or six minutes, metallic mercury, in the form of globules, is obtained, adhering to the sides of the tube, and mixed with the corrosive sublimate not decomposed, together with oxygen gas, which diffuses itself in the atmosphere, and a solid body, which occupies the bottom of the tube, and which is nothing but the muriate of potash, over and above the excess of potash employed in the experiment. Sometimes there is, likewise, a portion of oxyde of mercury not decomposed.

Rationale. The potash seizes on the muriatic acid of the corrosive sublimate, with which it has a greater affinity than the oxyde of mercury; a fixed muriate of potash is formed; the red oxyde of mercury being set at liberty, gives to the mixture this colour. This oxyde being of the number of those which are capable of being decomposed by the simple action of caloric, it is clear that there must be disengaged on the one hand, oxygen gas, and on the other, metallic mercury, the presence of which may be demonstrated by breaking the tube, when the globules may be perceived with the naked eye. It may, however, happen, that they are concealed by their union with the volatilized portion of corrosive sublimate. In this case, by detaching the crust adhering to the sides of the tube, and immersing it in water, the globulous mercury will be precipitated, and the sublimate dissolved in the liquid.

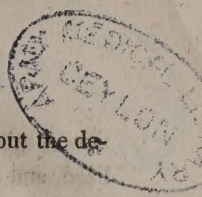
If the lapis infernalis is substituted, or the sub-carbonate of potash for the alcoholized potash, the same phenomena will take place; with this difference, however, that in employing these bodies, it is not easy to prove that the muriatic acid ob-

tained arises from the corrosive sublimate, since these preparations of potash themselves contain a number of muriates.

The experiment will succeed in the like manner if, instead of melting the alkali by itself, as we have pointed out, the deuto-muriate of mercury, and the alkali are melted together, being previously mixed in a glass mortar. It is only necessary to observe, in this case, that the whole mixture acquires a reddish colour from simple trituration.

31. If a mixture of four parts of corrosive sublimate and one part of antimony, both finely powdered, be heated very gently in such a tube as we have mentioned, muriate of antimony *(Butyrum Antimonii)* will be instantly formed, which will be condensed on the upper part of the tube; a portion of the corrosive sublimate becomes volatilized; and, lastly, at the bottom of the instrument will be found a residue, composed of metallic mercury, a portion of muriate of antimony, and probably a little antimony; sometimes the mercury is discovered through all these bodies. Often, however, it cannot be perceived, being concealed by them; in which case, if the residue is put into water, this fluid will take up all that is soluble, and the mercury will subside in metallic globules. It is essential to the experiment not to heat the tube beyond four or five minutes; for, if longer heated, the mercury will fly off. Neither must a much larger proportion of antimony be employed than is here pointed out, that the superfluous portion, in uniting with the revivifying mercury, or at least in enveloping it, may not prevent it from being discovered.

Rationale. The antimony has a stronger affinity for oxygen and for muriatic acid than the metallic mercury has. It carries off then these two principles from the deuto-muriate, in order to pass into the state of muriate of antimony exceedingly volatile, and the metallic mercury remains at the bottom of the tube. Caloric here, as in all cases where highly volatile pro-



ductions are formed, contributes greatly to bring about the decomposition.

32. Corrosive sublimate dissolves in about eleven times its weight of cold water. According to a series of experiments, instituted by M. Henry, 100 gramms of distilled water, at the ordinary temperature (from 12° to 16°), can hold in solution 8 gram. $\frac{7}{10}$ of corrosive sublimate. Boiling water dissolves a great deal more of it, since two parts are sufficient to hold one in solution. This solution, thus loaded, crystallizes on cooling, and furnishes crystals, which have been wrongly compared to the points of swords or poniards (vide § 25). If the corrosive sublimate contains any of the sub-muriate of mercury, the solution is never complete, since that body is insoluble in water. This salt, thus dissolved, presents a transparent fluid, without colour or smell, of a styptic, metallic, disagreeable taste, turning the paper and infusion of tournesol red, and the syrup of violets green.*

33. This solution, distilled in a retort, sends over a fluid, which is condensed in the recipient, in which the presence of a portion of volatilized corrosive sublimate with water can be demonstrated. This fact, which we shall again have recourse to hereafter, will prove very useful to us.

34. The solution of saturated carbonate of potash,† precipitates the corrosive sublimate in a very deep brick-coloured sediment. This precipitate is carbonate of mercury, at the maximum of oxydation; there remains in the liquor muriate of potash. This decomposition takes place by virtue of the law explained in the note of § 21. The carbonate of mercury, thus obtained, heated in a tube, such as before men-

* M. Chaussier attributes the green colouring of the syrup of violets to the combination which takes place between the yellow colour of the oxyde of mercury and the blue colour of the violet.

† By saturated carbonate of potash must be understood, that which contains the greatest possible proportion of carbonic acid. It is still, however, with excess of alkali.

tioned, gives out globules of mercury, which become volatilized, and adhere to the sides of the glass, together with carbonic acid gas, and oxygen gas, which are disengaged. The explanation of these results is easy, considering the facility with which the oxydes of mercury part with their oxygen at an increased temperature.

35. The caustic alcoholized potash, poured in small quantity into a saturated solution of deuto-muriate of mercury, forms a yellowish red precipitate. This precipitate collected, is found of a bright yellow; it is a sub-deuto-muriate of mercury; that is to say, muriate of mercury, at the maximum of oxydation, with excess of base. If, on the contrary, an excess of potash is poured upon it, the precipitate formed will be the oxyde of mercury at maximum, of a beautiful yellow. The potash having a stronger affinity for the muriatic acid, seizes that acid, and the oxyde is set at liberty. If the quantity of potash necessary for producing the total decomposition of the salt is not employed, then the precipitate will contain some muriatic acid. This precipitate of the oxyde, washed and placed on a filter till it becomes dry, takes a green colour on the surface, whilst it is yellow underneath. If it be heated in a glass tube, it becomes more and more dry, and at length red; by augmenting gradually the action of the caloric, it becomes decomposed into oxygen, which flies off in a state of gas, and metallic mercury, which becomes volatile, and adheres to the sides of the tube. If this oxyde be pure, there should not be any residue.

If the solution of corrosive sublimate is very much diluted, for example: 10 of Baumè's *areometre*, the caustic potash throws down a white precipitate, which, when collected, will be found white, or brick, or rose-coloured: this fact will be useful to us hereafter.

36. The sub-carbonate of potash (salt of tartar) produces in the solution of corrosive sublimate, a clear, brick-coloured precipitate, composed of carbonate and oxyde of mercury.

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This precipitate never begins by appearing white, as has been asserted, at least if the solution of sublimate be not considerably diluted. Being heated in a small tube, it gives out metallic mercury, oxygen gas, and carbonic acid gas.

37. Lime water in small quantity, precipitates the solution of corrosive sublimate of a deepish yellow colour. If the quantity of alkali be increased, the precipitate becomes red, and consists of oxyde of mercury retaining a little muriatic acid. Lastly, by the addition of a fresh quantity of lime-water, the precipitate is transformed into an oxyde at maximum of a beautiful yellow. Being heated, it gives out oxygen and metallic mercury.

38. The action which ammonia exerts on the deuto-muriate, is very remarkable. This alkali produces a white precipitate, composed of muriatic acid, ammonia, and oxyde of mercury, which is a true triple insoluble salt. It does not become slaty, as is stated in the works on *Médecine Légale;* and it even preserves its beautiful white colour after it has been washed and dried in the ordinary temperature. Being heated, it grows yellow; it passes afterwards to red, and gives out ammoniacal gas, azotic gas, muriate of mercury at minimum (proto-muriate of mercury or calomel), and metallic mercury. This last product can easily be seen on examining by the assistance of a magnifying lens, the crust of sub-muriate of mercury volatilized, and adhering to the sides of the vessel. It may be seen that in this operation, the oxyde of mercury has been de-oxydized by the hydrogen of a portion of the decomposed ammonia.

39. The hydro-sulphuret of ammonia gives a black precipitate with the solution of corrosive sublimate. Nevertheless, if a very small quantity of the hydro-sulphuret be employed, a precipitate mixed with gray and white would be procured, which would not become black, but by the addition of a greater quantity of the hydro-sulphuret. This black precipitate is composed of sulphur and mercury.

The Rationale is the same as what we have given in treating of metallic mercury. (§ 17.)

This sulphuret of mercury may, according to circumstances, present a colour more or less inclining to red, and it may even become very red; which depends upon the different proportions in which the sulphur and mercury are capable of uniting. All these sulphurets, when dried and heated in a small tube with iron filings, give out in a very small space of time volatilized mercury, adhering to the sides of the vessel, and sulphuret of iron, which remains at the bottom. It is clearly seen here, that the decomposition of the sulphuret of mercury, is greatly assisted by the tendency of the mercury to become volatile, while the sulphuret of iron is at the same time fixed.

Sulphurated hydrogen, and hydro-sulphurated water, equally throw down a black precipitate with the solution of the deuto-muriate, provided they are employed in sufficient quantity. These precipitates are likewise sulphurets of mercury.

40. Nitrate of silver is precipitated by the solution of corrosive sublimate, and the precipitate consists of muriate of silver, which is white, curdled, very heavy, insoluble in water or nitric acid, soluble in the liquor of ammonia, and acquires a black colour when exposed to the air. The liquid which swims above it, contains nitrate of mercury. The explanation of this phenomenon brings us back to the note of § 21.

41. The muriate of tin, at the minimum of oxydation, gives a white precipitate with corrosive sublimate. This precipitate is the sub-muriate of mercury (muriate at minimum).

Rationale. The tin being but little oxydated, and more eager for oxygen than the mercury, seizes a part of that which is contained in the sublimate, passes into the state of muriate of tin at maximum, which remains in solution; whilst the muriate of mercury at minimum which is produced, is precipitated on account of its insolubility.

42. The triple prussiate of potash gives a white precipitate, with the solution of the deuto-muriate of mercury. This

precipitate, in the course of a short time, becomes yellow, and afterwards passes into a clear Prussian blue. All these changes of colour are generally produced in the space of six and thirty hours. This precipitate is formed of prussiate of mercury, and prussiate of iron.

Rationale. The corrosive sublimate of commerce contains muriate of iron; therefore, since the prussic acid is capable of forming insoluble prussiates with the oxydes of mercury and iron, whilst, at the same time, the potash is capable of producing a soluble muriate, the decomposition must necessarily take place.

If, after washing, filtering, and collecting this blue triple prussiate, it be heated in a small glass tube, metallic mercury will be observed to be volatilized, which will be found adhering to the sides of the tube; in the mean time prussic acid is disengaged, distinguishable by the smell; lastly, there remains at the bottom of the tube a black substance, containing oxyde of iron and charcoal, which may be separated by the muriatic acid. This charcoal proceeds likewise from the decomposition of a part of the prussic acid contained in these prussiates. If the precipitate in question had not been well washed, there would be found beside in this residue when calcined, sub-carbonate and prussiate of potash.

43. If metallic mercury be put into the solution of the deuto-muriate, the mercury immediately becomes tarnished, and the solution troubled; in the course of five or six minutes a grayish precipitate will be perceived lying on the top of the metallic mercury not attacked. This precipitate, washed, dried, and cleared of the superfluity of metal, gives on analysis only muriate of mercury at the minimum of oxydation, and the solution no longer contains sublimate: whence we may conclude, that the muriate at minimum, proceeds in part from the sublimate decomposed by a portion of mercury which carries off a part of its oxygen and muriatic acid, in order to transform itself into muriate at minimum.

Fodéré, in the second edition of his "Médecine Légale," asserts; "that sublimate and fluid quicksilver triturated together with lime-water, form a black mixture." This assertion is true; but the fact requires to be explained with more precision, without which we may be led into error. If sublimate in powder be triturated with quicksilver, until the latter no longer appears in the form of globules, the production becomes black on the addition of lime-water, because the muriate at minimum formed during the trituration, yields the black oxyde which enters into its composition. But if lime-water be poured upon mercury, and a solution of corrosive sublimate be immediately added, no other precipitate will be obtained than the yellow oxyde of mercury, even if triturated for an hour. In short, if powdered sublimate and metallic mercury be mixed with lime-water, a yellow precipitate will at first be obtained by agitation, but which will grow black in proportion as the mercury and sublimate become transformed into muriate at minimum.

44. If a plate of copper perfectly freed from impurities, be plunged into a solution of corrosive sublimate, and left there for an hour or two, a powder will be seen deposited at the bottom of the vessel of a white colour, slightly inclining to gray: the plate of copper becomes covered with a coat somewhat tarnished, which can be easily removed by the finger, and which is formed of the same substance; lastly, the liquor, which was before colourless, becomes green. This whitish powder, which has been affirmed to be mercury extremely divided, is a mixture of muriate of mercury at minimum, an amalgam of mercury and copper, and a small proportion of mercury. This may be ascertained by submitting it to the action of caloric in a small glass tube; when the metallic mercury and the muriate at minimum become volatilized and condensed on the sides of the tube,* whilst the copper remains at the bottom.

* To demonstrate the existence of these two bodies, the tube must be broken, and the crust adhering to it detached. It must then be put into

Rationale. The copper has a stronger affinity both for the muriatic acid and for oxygen, than the mercury has: consequently a portion of this metal is precipitated from the moment the plate is plunged into the solution, and muriate of copper is formed. This action would go on in the same manner to the end of the operation, if a new power did not come in to disturb it. The mercury being precipitated in a state of extreme division, acts upon a portion of the sublimate not yet decomposed; it transforms it into muriate at minimum, which subsides. (§ 43.) On the other hand, in proportion as a part of the mercury is applied to the plate of copper, some electric fluid is disengaged by the contact of these two metals,* which may be compared to two plates laid one on the other. This electric fluid being disengaged, decomposes the water, oxygen is liberated, and the hydrogen arising from this decomposition, acts upon the muriate of copper already formed, and on such part of the sublimate as is not decomposed, seizes on the oxygen contained in their oxydes, and the copper and metallic mercury being set at liberty, form a precipitate composed of an amalgam of these two metals and free mercury.

If the plate of copper, which served to decompose the solution of the deuto-muriate, be taken, and the tarnished coat above mentioned be detached with the finger, it will be

distilled water, with alcoholized potash; the whole immediately becomes black, muriate of potash is formed, and the gray oxyde of mercury subsides, together with metallic mercury, perfectly brilliant; the whole is to be agitated and decanted. By these means, the gray oxyde of mercury passes with the water in which it remains suspended. This oxyde when subsided, being well washed, and dissolved in nitric acid, pure and diluted, gives a solution which affords a red precipitate with the chromic acid, a white one by the muriatic acid, and a blackish gray by the liquor of ammonia: characters peculiar to the salts of mercury at minimum.

* It is demonstrated in electricity, that the contact of two different metals disengages a certain quantity of this fluid, on which principle the theory of the Voltaic pile is founded.

seen that the colour of this plate is nearly black ; nevertheless, on rubbing it with a piece of paper, it becomes white, shining, and of a silvery appearance ; which phenomena depend on the coat of metallic mercury with which it is covered. If in this state it be exposed to the action of heat, the mercury flies off, and the plate resumes the proper colour of copper.

If, however, instead of treating it thus, we take a drop of the solution of the deuto-muriate, and let it fall on the plate of copper freed from verdigrise, a brown spot will appear, which by rubbing it either with the finger or a piece of paper, becomes white, shining, and silvery. Lastly, if instead of rubbing this brown spot, it be left to dry without agitation, it will be seen to turn of a beautiful green colour, which is owing to the muriate of copper of which we have spoken.

45. All the precipitates of which we have treated in § 34, 35, 36, 37, 38, and 42, rubbed on a plate of clean copper, render it white, brilliant, and silvery; which is easily conceived, when we consider their particular nature, and the tendency which copper has to unite with mercury.

46. If instead of a plate of copper, we plunge into the solution of corrosive sublimate a plate of zinc, we perceive that this metal immediately loses its brilliancy, the fluid becomes troubled, and throws down by little and little a powder in tolerable quantity, of a darker colour than that which we have described, as precipitated by the copper : the fluid becomes clear, and remains of a white colour ; but it no longer consists of corrosive sublimate : it is a real muriate of zinc. The powder separated from the liquid by decantation, washed with cold water, and placed on a filter, gives on analysis, 1st, metallic mercury : 2nd, muriate of mercury at minimum : 3rd, an amalgam of zinc and mercury : 4th, iron : 5th, charcoal.

The theory of this decomposition is the same as we have laid down in § 44, in speaking of the action of copper on the deuto-muriate. It appears at first a little more complicated in consequence of the iron and charcoal : but it is easy to ac-

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count for the presence of the former of these bodies, when we recollect, that the corrosive sublimate of commerce contains muriate of iron, the metal of which is precipitated by zinc, as Bergman has proved in his Opuscula, tom. ii.: as for the charcoal it is clear that can only proceed from the zinc, which always contains carburet of iron. It is by the following means that we may be certain that the composition of the powder is such as is pointed out above. In the first instance, in proportion as it dries upon the filter, the mercury is seen to unite itself in large globules, which can be separated.* The remaining portion heated in a glass tube, gives out a volatile production composed of muriate at minimum and metallic mercury, which can be analyzed by the means pointed out in the note to § 44, and a fixed product formed of zinc, of iron more or less oxydated by the action of caloric, and of a little charcoal. In fact, this residue, treated by pure muriatic acid, gives out charcoal insoluble in that acid, and a yellowish liquid, which is nothing else but a muriate of zinc and iron, from which the oxyde of iron may be separated by an excess of ammonia.†

47. Vegetable substances, according to Mr. Boullay's experiments, decompose the solution of corrosive sublimate. If a mixture of this salt be made with the distilled waters of certain plants, with the root of the *Lapathum Sylvestre*, the extracts, oils, syrups, honeys, and gums, muriatic gas will be perceived to be set at liberty, and calomel will be precipitated, with a portion of the vegetable matter which has undergone some change. A formation

* In order to obtain almost the whole of the metallic mercury, the dry powder should be triturated in a glass mortar, and all the metallic portions may be observed to unite themselves in escaping from the action of the pestle.

† It may happen in making this experiment, that charcoal is not obtained. In this case the powder has been too much heated, and this substance is burnt.

of water and carbonic acid takes place at the same time. The time required to effect this decomposition is variable. The decoction of tea throws down instantly a grayish yellow precipitate in flakes, which becomes pulverulent, and of a violet colour, by desiccation: while at the same time, if water be much loaded with sugar, no disturbance takes place till after several days; and alcohol produces no effect for the space of three or four months. Nevertheless, in these three instances, the same products are formed, and the sublimate is transformed into muriate at minimum, as may be ascertained by the means pointed out § 21. All these precipitates, on being heated with potash give out metallic mercury.

Rationale. All vegetable substances consist of hydrogen, oxygen, and carbon: they only differ from one another in the proportions of their constituent principles. Those of which we have just spoken, are capable of entering into combination with a greater quantity of oxygen; consequently, they carry off from the corrosive sublimate, a part of that which is contained in its oxyde, bring it down to the state of a muriate at minimum, whilst the hydrogen and carbon pass into the state of water and carbonic acid.

It is even possible, that these substances may carry away the whole of the oxygen contained in the yellow oxyde, and precipitate from it the metallic mercury.

48. By agitating in a small bottle, with a ground stopper, a mixture of sulphuric ether and corrosive sublimate in solution, and leaving the whole to stand for half an hour, the fluid will be found divided into two layers, the upper one of which will be turbid, and the lower one clear. The upper fluid will be formed by the ether holding almost all the sublimate in solution. If these two fluids be separated by the assistance of a funnel, it will be found to be covered with a white powder, wherever the fluid has come in contact; this powder is nothing but the sublimate abandoned by the ether, the extreme facility of the evaporation of which is favoured by the pouring of it

into the funnel. From this ethereal fluid a yellow orange precipitate will be formed by lime-water, a black one by the hydro-sulphurets, and a white one by ammonia; certain proofs of the presence of the salt in the ether. The inferior fluid, composed of water, which has yielded to the ether almost all the sublimate, retains still a little of it by means of the small proportion of the ether which has united with it.

49. If twelve grains of corrosive sublimate be dissolved in distilled water, and six ounces two drachms of burgundy wine be mixed with the solution, it will not be turbid; but the liquid resulting from this combination possesses properties which it is of great importance to understand. Potash will throw down a black precipitate; ammonia a very deep green, bordering on black; the prussiate of potash, a white, which goes into a violet; syrup of violets, far from becoming green, grows red. The plate of copper and the hydro-sulphurets act precisely as in the simple solution of corrosive sublimate.—These facts prove to a demonstration, that in a case of poison in a person whose stomach may contain wine, no attention ought to be paid to the action of re-agents which change the colours of the precipitates. If a greater quantity of sublimate be added to the wine, it becomes turbid, and deposits a violet coloured precipitate.

50. The action of albumine, on the solution of corrosive sublimate, holds out the greatest interest, and deserves to be explained in detail.* If a great quantity of sublimate be poured into the albumine, a white flaky precipitate is formed, which collects together immediately; this precipitate, when perfectly washed, dissolves slowly and in small quantity in an excess of albumine. After being dried upon the filter, it generally appears in the form of small hard pieces, brittle, and easily pulverized, semi-transparent, more particularly towards their edges, of a yellowish colour, without taste or smell, un-

* The albumine, of which we are here speaking, is only the white of eggs diluted with water, and filtered.

alterable by the air, and insoluble in water. Heated in a small glass tube, they become turgid, black, and go into decomposition, in the manner of animal substances; giving out a smell resembling burnt horn, and abundance of smoke. If after the operation, the tube be broken, there will be found at the bottom a charcoal, extremely light, and the inside of the tube hung round about half way up, with globules of mercury. If instead of making this experiment in an open tube, it be made in close vessels, all the product of the operation may be collected. The nature of these products demonstrate, that this precipitate is formed of muriate of mercury at minimum, and animal matter.

The apparatus in which the experiment should be made (*Vide fig.* 2), consists of a retort with a long neck *A*, into which this yellow body is to be introduced; a porcelain tube *B*, which passes through a reverberating furnace filled with charcoal.—This tube must be coated on the outside with a lute which is capable of resisting a very great degree of heat: a simple tube *C*, which is plunged down to the bottom of a bottle with two necks *D*, containing distilled water, to the height of about two lines: lastly, a safety-tube E, communicating by means of its curvature *e*, with the inside of the vessels placed in the mercurial trough *P*. The apparatus being mounted, the joints must be all completely luted, and the operation may proceed.

Experiment.—Begin by making the porcelain tube red hot; the air of the apparatus, being rarefied by caloric, escapes. The retort *A* is then gradually heated, and in the course of a short time, the substance contained in it is observed to swell; it becomes turgid, and black on the outside; gives out a portion of gas, so that the water in the bottle *D* becomes turbid.

The products of this operation are—1st, Charcoal, which remains in the retort; 2nd, metallic mercury, volatilized and adhering to the sides of its neck; 3d, muriatic acid, contain-

ed in the bottle *D*, the tube *C*, and the neck of the retort; 4th, lastly, all the products resulting from animal substances, decomposed at an elevated temperature.

Ninety grains of this precipitate dry, furnished thirty grains of metallic mercury, four grains of muriatic acid, and fifty-six grains of animal matter. These proportions of acid and mercury being nearly the same as what constitute the muriate of mercury at minimum, we must conclude, that in reality the precipitate analyzed, is a compound of that salt and of animal matter.*

Rationale. The albumine, from the action of caloric, is transformed into charcoal, which remains in the retort, and into several other volatile productions. The charcoal acts upon the muriate of mercury at minimum, and transforms it into metallic mercury, which becomes volatile, and adheres to the sides of the glass, and into carbonic and muriatic acid, which pass over.

The correctness of this fact besides may be put out of all doubt, by the following experiment:—If a quantity of this same precipitate dry and finely powdered, be made to boil for half an hour with a solution of caustic alcoholized potash, it will be found, that a muriate of potash is formed, and that a black oxyde of mercury is deposited, soluble in nitric acid, with which it forms a nitrate of mercury at minimum.

It is evident, that in this operation, the potash decomposes the muriate at minimum, by virtue of the superior affinity it is endowed with for the muriatic acid.

* The metallic mercury is easily obtained by breaking the retort, and detaching, by means of a glass tube, and a little distilled water, hot, whatever adheres to the fragments; if the liquid obtained be left to settle, the metallic mercury is seen to subside to the bottom. In order to determine the quantity of muriatic acid, all the fragments of the retort must be treated with distilled water, the tube *C* completely washed, and these two portions of fluid must be united to that contained in the bottle *D*; it must then be precipitated with the nitrate of silver. This salt gives out a quantity of muriate, which makes known that of the muriatic acid.

If, instead of pouring a great quantity of corrosive sublimate into the albumine, a very small quantity only be used, the fluid becomes turbid, milky, and throws down no precipitate till after the expiration of several hours. If this be filtered, the white precipitate of which we have just given the history, is obtained, and a fluid perfectly limpid passes through, which is no other than albumine, retaining in solution a portion of the precipitate.

When a less quantity of albumine is employed than in the foregoing case, the same appearances take place, with this slight difference, that the filtered liquid is composed of a portion of the precipitate dissolved in the albumine, and of a certain quantity of corrosive sublimate. In fact, it turns the tincture of tournesol red, and the syrup of violets green; it gives black precipitates with the hydro-sulphurets; it acts upon a plate of copper precisely as the corrosive sublimate; it gives a white precipitate on the addition of more albumine, and in that case contains no more muriate at maximum. To these experiments, which prove the existence of corrosive sublimate, we may add those which demonstrate the presence of albumine. The nitric acid produces a white precipitate; the solution of corrosive sublimate separates from it instantly white flakes; lastly, it is coagulated by the action of caloric, or only rendered of an opaline appearance, according as the quantity of albumine is more or less considerable.

From these experiments it must be concluded, that albumine, thus combined with the precipitate, is capable of forming a soluble body with corrosive sublimate.

51. If, into a solution of corrosive sublimate, concentrated and boiling, be poured gelatin dissolved, and of the same temperature, the liquor preserves its transparency; but in proportion as it grows cold, it is seen to become turbid, and to let fall an abundance of white, solid, gluey, and gelatinous parts, which disappear, as well as the thickness of the fluid, whenever the heat is again raised to the degree of ebullition.

If, instead of attempting it by heat a concentrated solution of gelatin, at the ordinary temperature, be mixed with a concentrated solution of corrosive sublimate, the same turbidness and the same sediment, will be observed; and the liquor, as in the last experiment, regains its transparency on being exposed to the action of heat. The same phenomena take place, if the jelly arising from a solution of isinglass be dissolved in cold water, then made hot and afterwards cooled. If this liquor, hot and transparent, be left to itself, it will be seen, that it will no more become turbid by cooling. At the end of some days, small white flakes are seen to attach themselves strongly to the sides of the vessel, or rise to the surface of the liquor, and swim in a kind of froth which forms there. These flakes laid upon the fire, give out a smell similar to horn which is burning: being washed with alcoholized potash, they instantly grow black, and furnish black oxyde of mercury, while at the same time muriate of potash is formed. From these circumstances we may conclude, that the solution of gelatin produces on the corrosive sublimate the same kind of decomposition that the albumine does; that is to say, it transforms it into muriate of mercury at minimum, which enters into combination with a portion of animal matter. This triple body may be obtained very easily, by boiling for an hour two concentrated solutions of gelatin and sublimate. The sides of the phial will be hung round with a gluey coating, which partly becomes detached, under the form of membranaceous filaments, and which are nothing but the body of which we have just been speaking. It is unnecessary to observe, that in heating this body when dried, metallic mercury will be procured.

52. *Osmazome* dissolved in water, and added to corrosive sublimate, gives a precipitate of a reddish yellow, which becomes red on desiccation. This precipitate heated in a glass tube, furnishes metallic mercury, and the animal matter is decomposed.

53. The solution of sugar of milk is not rendered turbid by the corrosive sublimate.

54. The case is the same with the resinous matter of bile, dissolved in boiling water, and filtered after cooling.

55. The solution of *Picromel* does not at all disturb that of corrosive sublimate; however, at the end of some days, a whitish precipitate is formed, which is gluey, and in small quantity.

56. If a portion of fibrin, or a piece of flesh, be added to an aqueous solution of corrosive sublimate, a white precipitate is instantly observed to be formed, which is no other thing than the muriate of mercury at minimum; the flesh loses the cohesion of its parts, and becomes friable.* The liquor turns the syrup of violets red, instead of green; which proves that it contains a free acid; a chemical analysis shews it to be the muriatic acid, consequently the corrosive sublimate has been decomposed by the animal fibre.

57. A concentrated solution of corrosive sublimate brought into contact with a large quantity of milk, produces no visible change. However, the colour of the precipitates formed by the different re-agents, will only be the same, while the salt is free from mixture of any kind. If one drachm of the concentrated solution of corrosive sublimate be added to 14 drachms of milk, the liquid becomes of a sky blue colour with the syrup of violets; of a blackish gray with caustic potash; yellow passing afterwards to blue, with the prussiate of potash; black with the hydro-sulphuret of ammonia; and a plate of copper immersed in it undergoes the same changes as with the sublimate.

The same phenomena will be observed with a mixture of three drachms of milk and one drachm of the concentrated solution of this salt. If seven or eight parts of this solution and one part of milk be employed, a white coagulum is

* Essay on the Causticity of Metallic Salts, by M. Berthollet, Memoir read in 1779. Vide Académie des Sciences, 1780.

instantly formed, which collects together, and over it floats a liquor extremely clear. This coagulum washed, is easily dissolved in milk, which circumstance accounts for the impossibility of obtaining it when only a small quantity of sublimate is employed. When dried upon the filter, it is solid, of a yellow colour, not very hard, unalterable by the air, and insoluble in water. On being heated, it gives out metallic mercury, and when submitted to analysis, it is found to be formed of muriate of mercury at minimum, and of the caseous and butyraceous parts of milk.

58. Ordinary soup, filtered and perfectly limpid, mixed with a small quantity of corrosive sublimate in solution, becomes slightly turbid, without giving any precipitate. The plate of copper, syrup of violets, prussiate of potash, ammonia, nitrate of silver, and the hydro-sulphurets, produce the same effects in this mixture as in the solution of corrosive sublimate. But it is not the same with respect to the caustic potash in solution, and lime-water. The first of these alkalies throws down a white precipitate, or a gray, or a red one, instead of a yellow, as would be the case, if there was an excess of corrosive sublimate. Lime-water produces in this mixture a precipitate of a dirty white colour, or else a white slightly tinged with yellow.

If, instead of the above experiment, five or six parts of corrosive sublimate be mixed with one part of broth, a white precipitate is instantly obtained, extremely heavy, full of flakes, and which collects easily together. This precipitate dried, is of a grayish colour, extremely hard, brittle, unchangeable by the air, and insoluble in water. Being heated in a small glass tube, it gives out metallic mercury, and the various productions furnished by animal matter when submitted to the action of caloric. If treated by potash, and distilled water it becomes decomposed, and a black oxyde of mercury is obtained with muriate of potash, which proves that it contains muriate at minimum, and consequently that the broth possesses, like all

other animal substances, the power of converting the corrosive sublimate into mercurius dulcis.

59. If one part of human bile, diluted with an equal bulk of water, be added to a tenth of the concentrated solution of corrosive sublimate, a precipitate of a yellow colour, inclining to red, will be obtained in tolerable abundance. The same thing will take place if the bile be diluted with twenty times its bulk of distilled water, only in this last case, the precipitate takes more time to collect together. If put on a filter and dried, it appears in the form of a reddish powder, composed of animal matter, and of muriate of mercury at minimum: so, likewise, by the action of heat, it furnishes metallic mercury.

It sometimes happens, that no precipitate is formed from the combination of bile and sublimate in the proportions just mentioned. This phenomenon depends on the different principles that may be found in the bile, the alterations of which, though little known, vary *ad infinitum*. Nevertheless, if this transparent mixture be left to itself, it becomes turbid after a certain time, and the corrosive sublimate is reduced to the state of muriate at minimum, which is precipitated with a portion of animal matter.

M. Marc, in a medico-legal consultation,* reports, that a mixture made by one grain of sublimate, and one drachm of bile, dissolved in an ounce of water, did not furnish any precipitate, either with ammonia, or with potash, notwithstanding these alkalies precipitated a solution made with the same quantity of sublimate, without bile. The alkaline sulphuret and lime-water, precipitated a solution, in which the alkalies did not produce the slightest degree of turbidness. I have often repeated these experiments, and always with the same results. It is easy to perceive how important these facts are in determining cases of poisoning by corrosive sublimate.

* Consultations Médico-Légales, p. 101, Op. Citat.

ACTION OF CORROSIVE SUBLIMATE TAKEN INTERNALLY.

60. Corrosive sublimate administered internally, in a very small dose, for instance, the eighth of a grain, produces a temporary excitement of the alimentary canal, of the organs concerned in the circulation, and in several of the secretions. The local phenomena it produces are not very evident, if we except a sense of heat, and, as it were, a nipping in the stomach.

If the dose of this salt be a little stronger, and especially if the use of it has been too long continued, it gives rise to cholics and vomitings. The salivary glands inflame, and become very painful. The saliva, which is secreted in too great quantity, becomes acrid, corrosive, and of an infectious smell; the tongue and gums swell, and present spreading ulcers, extremely painful; the teeth begin to grow black, and loose, they fall out, and their loss is sometimes followed by that of the bones of the palate, or maxillæ; the breath is fetid; the face and whole head swelled, which renders deglutition and respiration difficult; the voice is suppressed, or else resembles a lowing. Cardialgia, dyspepsia, diarrhœa, dysentery, various inflammations, dyspnœa, hoemoptysis, phthisis pulmonalis; very violent pains in the muscles, tendons or joints; tremors of the limbs, paralysis, tetanos, mania, and death, may possibly be the result of the improper use of this substance. In this case the corrosive sublimate is absorbed, and it is possible that it may even change its nature, in such manner as to appear under the form of globules, in the large cavities of the body, in the viscera, in the joints, in the bones, in the sheaths of the tendons; as has been proved by a number of authentic facts.*

* Miscellanea Medico-Physica, Academiæ Naturæ Curiosorum Germaniæ, annus primus, obs. 81. scholion.

Rosini Lentilii Miscellanea Medico-Practica, p. 74, Ulmiæ, 1698.

Wepferi Observationes Anatomicæ, p. 303.

61. When administered in a large dose, it acts as a violent poison, gives rise to the most serious accidents, and produces death in a very short space of time. In what manner does this poisonous substance produce its effects? and which of our organs first feels its fatal operation?

Amongst the authors who have attempted to resolve these difficult questions, the first deserving our attention are Dr. Lavort, physician of the *Ecole de Paris*, and Mr. Brodie, an English physiologist. We shall give the result of their labours, adhering principally to those of Mr. Brodie, which appear to us the most decisive.*

62. This physiologist is of opinion, that the sublimate introduced into the stomach, exerts a corrosive action on that viscus; that this action is extended, by sympathy, to the heart and the brain, and that death is the result of the suspension of the functions of these two organs so essentially necessary to life. He supports his opinion on the following experiments.

Experiment 1st. Mr. Brodie injected into the stomach of a rabbit, by means of an elastic gum catheter, six grains of corrosive sublimate, dissolved in six drachms of distilled water. Three minutes after the injection, the animal, without the least previous suffering, became insensible, experienced some convulsive movements, and died four minutes and a half from the time of the injection. After death, a trembling of the voluntary muscles was observed, which continued for some

Turquet de Mayerne, la Pratique de Médecine, C. viii. p. 61, an. 1693.

Laborde, Journal de Médecine, tom. i. p. 37, 1778.

M. Pickel, professor of chemistry at Wurtsburg, obtained metallic mercury on distilling the brain of a person who had been long taking mercurial preparations. This fact was communicated to me by Professor Haindorf, of the Academy of Heidelberg.

* Considerations Medicales sur le Muriate de Mercurie sur-Oxygené Thèse soutenou le 22 Thermidor, an. 10 (1802).

Further Experiments and Observations on the Action of Poisons on the Animal System, by B. C. Brodie, read February 27th, 1812. (Philosophical Transactions).

time. On opening the thorax, the heart was found without the least movement, and the blood contained in the left side of this viscus of a scarlet colour. The stomach, which was greatly distended, contained in its cardiac portion the food taken by the animal, diluted with the injected fluid. The part next the pylorus contained some hard solid substances. In the middle of this viscus there was a strong muscular contraction, which had prevented the passage of the fluid from the upper to the lower part of it. The mucous membrane of this latter portion was in its natural state, but that belonging to the cardiac portion was of a brownish gray colour, and was easily torn. In some places its texture was completely destroyed, in such a manner as to resemble a pulp.

Experiment 2nd. A scruple of corrosive sublimate dissolved in six drachms of distilled water, was injected into the stomach of a full grown cat: five minutes after, the animal had two vomitings; was very uneasy, suffered much, but was motionless: the pupils of the eyes were dilated. Twenty-five minutes from the time of the injection, some convulsive movements of the voluntary muscles came on, and it died. On opening the thorax immediately after the death of the animal, the heart was observed to contract but very feebly. The stomach was perfectly empty; the whole surface of its mucous coat exhibited a brown gray colour; its texture was destroyed, and, as in the preceding experiment, it tore and separated from the muscular coat with great facility: that which forms a part of the first quarter of the duodenum presented a similar alteration, but less decided.

Experiment 3d. The same quantity of corrosive sublimate was injected into the stomachs of a rabbit and cat, dead. The alteration of the mucous membrane was, as nearly as possible, the same as what we have just described.

Mr. Brodie concludes, from these experiments, First, that the sublimate being dissolved and introduced into the stomach, corrodes the portion of membrane upon which it

rests. Secondly, That the brain and heart are affected; which explains the convulsions, the immobility, the state of pulse, and the sudden cessation of the motion of these latter viscera. Thirdly, that the lungs are no way concerned; since the blood of the left side of the heart preserves its scarlet colour.

The English physiologist does not hesitate to conclude, that the lesions of these two essential organs are the immediate cause of death; because the inflammation of the stomach could not produce it so suddenly. He is of opinion, that these two organs, connected by such numerous nervous ramifications with the stomach, are affected by sympathy. It appears to him impossible, considering the state in which the mucous membrane of the stomach is found, to conceive that the poison should be absorbed and carried into the circulation.

63. M. Lavort, rejecting all idea of the absorption of corrosive sublimate, had already given some opinions on this subject. "Supposing," says he, "part of the oxygenated muriate "of mercury to have passed into the channels of the circula- "tion, and calculating on the effects which this salt ought to "produce on the fluids with which it mixes, by the action it "exerts upon the solids which come under its influence, it "will appear how sudden the death ought to be which would "succeed such an inoculation. In short, it is easy to demon- "strate by daily observation and experiments made upon "living animals, that the smallest quantity of an acrid, or "caustic fluid, or even of one slightly acid, introduced into "the vessels of an animal, induces death with an extreme "celerity. But it is necessary to note, particularly in these "instances, that the symptoms which precede and which pro- "duce death, are not at all like those induced by the oxyge- "nated muriate of mercury, when externally applied. Many "animals that I have witnessed submitted to these experi- "ments, have never survived beyond a few minutes from the "injection of the fluid. In some, death has succeeded so "suddenly, that we have not been able to lay hold of any of

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"the symptoms which preceded it. Almost all of them "passed from life to death in a manner so little sensible, that "though they were under our eyes, we had great difficulty in "distinguishing the change. Immediately after the operation, "the animal fell into a state of torpor, the eyes closed, the "breathing gradually subsided, the motion of the heart be- "came imperceptible, and it expired without shewing the "slightest signs of pain."

"If this species of death be compared with that resulting "from the external application of oxygenated muriate of "mercury; if the symptoms which in both cases precede and "produce it, be examined together, we cannot avoid being "struck with the little analogy that exists between them. In "the first kind of death, sensibility appears extinct; the "animal goes off without giving any sign of pain. In the "second, sensibility is increased to the very highest degree, "and the animal expires in the most excruciating torments. "On one hand we see, spasms, convulsions, cold sweats, "delirium, and all that long series of symptoms which cha- "racterize lesion of the nervous system. The other state is "conspicuous for coma, torpor, insensibility; and we may "affirm, that if in both instances there exists a lesion of the "nervous system, it is at least in a manner diametrically oppo- "site to one another."*

SYMPTOMS PECULIAR TO POISONING BY CORROSIVE SUBLIMATE.

64. We shall commence by giving a report of some observations on poisoning by this salt, in order to be the better able to trace the general symptoms.

OBSERVATION I.

M. B., a merchant of Liege, aged thirty years, of a bili-

* Op. citat. page 19, and seq.

ous temperament, robust constitution, who had never felt any indisposition, came to Paris to settle some business with M. D., at whose house he lodged. On the 6th of August, 1813, he was attacked without any apparent cause, with a looseness, which continued three days, and which was successfully treated with ipecacuanha. On the 13th of the same month he appeared perfectly recovered. On that day the heat was very great, and M. B. being very thirsty, about three o'clock in the afternoon, returning to his lodgings, took a quantity of a certain spirituous and limpid liquor, contained in a bottle without any label.* The disagreeable flavour of this drink produced in M. B. so great a disgust and a dread of the imminent danger into which he might have brought himself, that he instantly left off drinking, spit out all that remained in his mouth, and broke the bottle in pieces, in which there still remained a small portion of the fluid. Unfortunately M. B. had swallowed part of it. A constriction of the throat, and excruciating pains in the epigastric region were the first symptoms which made their appearance. I was instantly sent for, and arrived at fifty minutes after four. I was told that he had vomited a great quantity of a greenish matter, bitter, but not at all bloody; and that he had passed three stools. I found him in the following condition.

Lying on the back, face red, swelled, and animated; the eyes were sparkling, and possessed of great mobility, the pupils contracted, the conjunctiva slightly injected, the lips dry, chapped, and of a natural colour, the tongue slightly moist, and covered with a yellowish coat. Excruciating pains extended themselves over the whole course of the digestive canal, and were particularly severe in the pharynx; the abdomen was tumefied and painful, especially when pressed. The

* I assured myself that this bottle contained corrosive sublimate dissolved in alcohol, the remains of a composition Mr. D———, his friend, had employed some days before for a venereal affection. Mr. B—— had no knowledge of the nature of this composition.

vomitings had ceased for some moments, but the alvine discharge continued; the stools were not very copious, and of a bilious appearance; the pulse regular, small, and tight, beat a hundred and twelve strokes in the minute; the heat of skin was intense and pungent, especially on the forehead; respiration difficult; urine scanty, rendered with difficulty, and of a red colour. External senses perfect; his answers were given slowly, and with difficulty, great tendency to fainting from time to time, convulsive motions of the muscles of the face, arms, and legs; and continual cramps in all the limbs. ("Six pints of albuminous water cold, given by a glass at a time, at short intervals; twenty leeches to the epigastric region, which were applied at five o'clock precisely; and two cold emollient glysters.")

At half past five, evidently better. He had taken the whole quantity of drink prescribed; had vomited much, and had four stools. ("Four pints of decoction of linseed, given a glass at a time; low diet. Impossible to apply fomentation, on account of the great tenderness of the belly.")

At six o'clock, fresh vomitings, cessation of cramps and of evacuations; pulse only a hundred, and of the same character as before; other symptoms continue; great desire to talk of all that had happened to him. At nine o'clock, a very imperfect sleep. At twelve complained of a smarting sensation near the bottom of the rectum; stools abundant and bloody; sharp pains in the arch of the colon; pulse still small and tight; beats a hundred and fifteen. ("Ten leeches on the course of the descending portion of the colon, three pints of water saturated with gum, two emollient glysters prepared with half a drachm of laudanum.") Fresh vomitings, four stools much less bloody, an almost sudden cessation of the pain; evidently better; inclination to sleep.

The 14th, at eight in the morning, (second day of the disease,) abdomen little swelled, and less painful; tongue moist; no inclination for stools or vomitings; anus slightly painful;

pulse expanded a little, and beats only at ninety-six; skin cooler; face less red; limbs a little stiff; no convulsive movement; senses and intellectual faculties perfect. ("An antispasmodic draught made with two ounces of orange flower-water, two ounces of peppermint-water, thirty drops of the anodyne mineral liquor, and an ounce and a half of syrup of orange-rind, four pints of decoction of linseed, to be taken in the course of the day; three emollient and narcotic glysters, at the intervals of two hours.") Fresh vomiting, fresh alvine evacuations, without blood, which have greatly relieved the patient. In the evening, an exacerbation; pulse an hundred and six, greater heat of skin, without increase of the pains ("Gum water, oily julep, emollient and narcotic glyster.") The 15th, in the morning (third day of the disease); the patient feels himself much better, has slept during part of the night; he no longer despairs; he takes pleasure in talking of the danger he was in; asks for food; tongue moist, pains diminished, great debility, pulse nearly in its natural state. ("Barley-water, soup, anti-spasmodic draught, emollient fomentations.") The evening, in the same condition. The 16th, in the morning, (fourth day of the disease,) the patient has slept tolerably well, and only complains of slight pains, and of no long continuance, in the epigastric region; appetite good. ("Barley-water and soup.") The 17th and 18th, in the same condition. The 19th, pains nearly gone; he has been allowed soup twice. The 21st and 22d, convalescent. The 30th, he was in very good health, and is set out for his own country.

Whoever pays the least attention to the commencement of this disease, will perceive how easy it would have been to confound it in the first instance with cholera morbus. In fact, the temperament of the patient, the bilious affection with which he had been attacked a few days before, the bilious vomiting, and stools free from blood, the convulsions, and cramps in the limbs, whilst the heat of the atmosphere was very great; all these things might have induced a belief that

such a disease existed. However, this narrative of the case, the chemical analysis of the fluids vomited, the avowal of the patient himself, prove to a demonstration the existence of poison. The disease with which Mr. B. was attacked was a real phlegmasia of the mucous membrane of the intestines, and of the peritoneum, complicated with a bilious affection, the developement of which was owing to the presence of the corrosive sublimate, and particularly to the predisposition of the patient.

It is of the utmost importance that the medical practitioner should never lose sight of the analogy, I might even venture to say, the perfect similarity that exists between the symptoms produced by certain poisons, and those which constitute several spontaneous diseases. Ignorance of this part of medicine may lead the person called on to determine in cases of poison, into the most serious errors.

OBSERVATION II.*

A man tolerably robust, and of a sanguine temperament, 40 years of age, about ten o'clock at night, took, no one knows why, the remainder of some corrosive sublimate which he had in the house for the purpose of destroying rats. The dose was not small. He dissolved this poison in some beer. The moment he had swallowed it, the mouth, œsophagus, and stomach, experienced its caustic effects. In a short time, inflammation of the mouth, and acrid and burning heat in the region of the stomach, with rending pains, succeeded to the first impression of the corrosive sublimate, and extended rapidly to the whole of the intestinal canal, with pains equally horrible as those at the stomach. Soon after the face swelled greatly, and became of a deep crimson. The eyes were sparkling, and the breathing very difficult. He felt great anxiety of the præcordia, with inquietude and continual

* This observation was collected by M. Dumonceau and Planchon. It has been extracted from the Journal de Médecine, l. xlix. p. 36.

tossings. The pulse was small, and indicated fever. Six grains of emetic tartar were given at first in a glass of water; little vomiting resulted from it, but the pains were greatly increased. In this state of perplexity a drachm of theriaca was administered to the patient, which produced no calm. The poison was making rapid progress, and M. Dumonceau was sent for without delay, who, on sight of the case, prescribed instantly a drachm of the salt of wormwood in a glass of water, in order to decompose the two metallic salts, especially the corrosive sublimate; to this he added incrassating and inspissating medicines. I was called in, and could not but approve the medicines prescribed by my colleague M. Dumonceau, and we agreed to persist in them. The excruciating pains, however, returned at intervals with great violence, and seemed to announce a corrosion of the internal membrane of the stomach and bowels. It had, in fact, taken place. The patient was passing bloody stools. Nevertheless, by the use of the "*sal. absinth.*" two drachms at a dose, dissolved in the *decoct. incrass.* of Fuller, (after having taken a drachm at twice, at the interval of a few instants,) he found a very evident relief. Although the pains returned again from time to time with great violence, they nevertheless subsided by little and little, insomuch, that the next morning a calm had succeeded to the storm. All the alarming symptoms had subsided, but there remained a painful sensation along the whole of the intestinal canal, and a general sense of weakness of the body which had sustained so rude a shock.

OBSERVATION III.

A child two years and a half old, who had entered by stealth into a goldsmith's shop, swallowed eight grains, or thereabouts, of corrosive sublimate. In a very short time he felt violent gripings, the belly swelled, and copious salivation ensued. Dr. Sigismund Konig administered an emetic syrup, to which he added some of the juice of the quince, which produced

very abundant vomiting. He afterwards ordered the patient to drink copiously of goat's milk, mixed with a mucilaginous decoction of Psyllium. (*Plantago Cynops*, Linn.)

The swelling of the belly disappeared, the griping subsided, and the child slept the night immediately subsequent to the accident.

Seventy-four days after, the patient was threatened with phthisis; the same physician thought it necessary to order again the goat's milk sharpened with the flowers of mallows and quince seeds. He affirms that the child was in very good health when he made the communication.*

OBSERVATION IV.

A cook being condemned to death for having stolen two plates of silver from his master, agreed with Charles IX. that he would swallow a certain poison, and immediately after some Bezahar, an antidote much boasted of to the king, of which his majesty greatly desired to know the efficacy. The unfortunate wretch was to be set at liberty if he escaped the action of the poison. Ambrose Paré relates this extraordinary event in the following manner:—"And soon after an apothecary "who attended gave him a certain poison in a potion, and "instantly after, the said stone of Bezahar. Having these "two good drugs in the stomach, he began to vomit, and "soon after to go to stool with great straining, saying that he "had a fire in his belly, and demanding water to drink, which "was not refused him. An hour after, being informed that "the said cook had taken this good drug, I begged of the Lord "de la Trousse that he would allow me to go and see him, "which he granted me. Accompanied by three of his archers, "I went and found the poor cook on all fours, crawling like a "beast, his tongue out of his mouth, always wishing to vomit,

* Jacobi Mangeti Bibliothec. Med. tom. iv. pars ii. p. 455. hist. 3. ex communicatione Excell. D. D. Sigismundi Konig, Physici bernensis. Genevæ, 1739.

" the eyes and the whole face like a torch, with profuse cold " sweats, and rendering blood from the ears, nose, mouth, by " stool and by urine. I made him drink about half a ' sextier' " of oil, thinking to assist him and save his life. But it was of " no use to him, because it was administered too late. He " died miserably, crying, that it would have been better for " him to have died on the gallows. He lived seven hours or " thereabouts; and being dead, I opened his body in the pre- " sence of the said Lord de la Trousse, and four of his archers, " when I found the bottom of his stomach black, dry, and " parched, as if a cautery had passed through, which made " me know that he had swallowed sublimate, together with the " symptoms which occurred during his life."*

We shall now give some observations to prove how dangerous it is to apply corrosive sublimate externally.

OBSERVATION V.

By Pibrac.

A merchant of Nantes came to Paris in order to be cured of a tumor, which occupied the middle and back part of the left leg, as large as two fists, adhering to the muscles, and of a carcinomatous character.

A private individual undertook to cure this disease by the application of a caustic. The remedy was applied, and produced an eschar. The patient already affirmed that he was relieved; he felt his leg lighter, and thought he moved it with more facility than before. The empiric removed a part of the eschar at the first dressing, with some portions of fungous flesh that were rising up like mushrooms round the circumference of the part cauterised; and he sprinkled all the raw surface with corrosive sublimate. The rapid vegetation of the fungus made me augur ill concerning the state of things; and my ideas though opposed to those of others, were unfortunately

* Œuvres de Paré, onzieme Edition, liv. xxi. *des Venins,* chap. xliv. p. 507.

but too well verified the very next morning. For the servant, who went to his master's bed to carry him some soup, found him dead.

OBSERVATION VI.

By the same.

A young lady, eight years of age, had two wens, one on the back of the neck, the other on the superior part of the occipital bone. They were opened by the application of the spirit of nitre. After the evacuation of the humour they contained, and which resembled tallow, corrosive sublimate was employed, to destroy the bottom of the cyst. The application of it was repeated, and the young patient experienced a fate still more cruel than the subject of the last observation. She died on the fifth day, in the most terrible convulsions.

OBSERVATION VII.

By the same.

A strong robust woman, aged 49 years, of a good temperament, having an ulcerated cancer of the breast, was entrusted to the care of an empiric, who employed upon her his white powder, externally applied. It was corrosive sublimate. The patient was in great pain after the application; the pains increased considerably, and in the space of four hours became intolerable. A crowd of symptoms occurred at once; oppression, nauseau, vomitings, which extended even to blood, convulsive motions the most violent. In fine, she suffered in every part of her body, a dreadful torture, from which she was not delivered till the next morning by a most horrible death.*

OTHER OBSERVATIONS.

Plenck speaks of a lady who died miserably, from having applied upon her body a plaster, into the composition of which

* Mémoires de l'Académie de Chirurgie, tom. iv. p. 154 *et seq.*

the corrosive sublimate entered. The symptoms preceding death, were great pains, convulsions, swelling of the throat, and salivation.

The head of a little girl, which had been anointed with a pomatum containing corrosive sublimate, for the destruction of vermin, became so much swelled, that great fear was apprehended for her life. She received relief from ley of ashes; her hair fell off, and she recovered.*

Degner reports a case of this kind of poisoning in which death was preceded by the most alarming symptoms.†

65. On considering the different symptoms observed in the patients, who form the subject of the preceding observations, we perceive that they can be reduced to the following: an acrid styptic, metallic taste in the mouth: a sensation of stricture and burning heat in the throat; anxiety and rending pains in the stomach, and in the whole of the intestinal canal; nausea, frequent vomitings of a fluid, sometimes bloody, accom-

* Plenck Toxicologia, Mercurius Sublimatus Corrosivus, p. 263. Viennæ, 1785.

† Degneri Historia Medica, de Dysenteriâ Biliosâ contagiosâ, p. 250, anno 1738.

We do not in any manner consent to the opinion of Dehorne, who thinks that the external application of corrosive sublimate is not so dangerous as it has been held out. He says, likewise, that the cases contained in the memoir of Pibrac, prove nothing against the innocence of that salt: that the facts reported by that author relate to cancerous tumours, which ought never to be excited by any stimulant or caustic application: that it is not the remedy which ought to be blamed in these cases, but the person who so rashly applies it. (*Exposition raisonnée des différentes Méthodes d'administrer le Mercure, par Dehorne*, p. 126, anno 1775.) We shall reply to these remarks; 1st,—That the young lady who forms the subject of observation 6th, was not affected with any cancerous tumour. She had only two wens, one on the back of the neck, the other on the superior part of the occiput. 2d,—That all the dogs on which we have ever made a wound of no great dimensions, which has been sprinkled with corrosive sublimate died at the end of five or six days, after having experienced all the symptoms of poisoning by sublimate, more especially the general insensibility of which we have spoken, § 62.

panied with violent efforts; diarrhœa; sometimes dysentery; pulse small, tight, and frequent: lypothimia, general debility, difficulty of breathing, cold sweats, cramps in all the limbs, general insensibility, convulsions, death. The imprudent and continued use of this salt in small doses, produces all the symptoms of which we have spoken (§ 60), in our examination of the action of the preparations of mercury on the animal economy.

LESIONS ESPECIALLY ATTRIBUTED TO CORROSIVE SUBLIMATE.

66. Are the different alterations of texture which result from the action of poisons, sufficiently well known; or do they present characters sufficiently specific, that it may be ascertained on inspection what poisonous substance has produced them?

Sallin, in his memoir on the research of the traces of poison on the body of Lamotte jun^r^. sixty-seven days after he had been deposited in the earth, decides in the affirmative, and affirms that this patient had been poisoned by corrosive sublimate. He makes a comparison of the lesions which would have been produced by arsenic, the ranunculi, Mandragore, opium, belladonna, hemlock, mineral acids, &c., with those which were presented by the body which formed the subject of the inquiry: and not being able to attribute these lesions to any of the above-enumerated poisons, he finishes by concluding, that corrosive sublimate had been employed to the exclusion of all the others. "This "salt," says he, "never produces perforation of the digestive "tube, it never acts upon the mouth or œsophagus; it de- "stroys, burns, and detaches the mucous membrane of the "stomach without altering the muscular coat. The traces of "its action extend nearly to the cœcum, and it produces no "eruption on the skin."*

* Sallin observes, "We have perceived on the exterior surface of the

The assertion of Sallin does not appear to us admissible. Experiments made upon animals, and a collection of cases of poisoning, stated with great care, prove, in a manner incontestable—1st, that a general inflammation of the alimentary canal, as well as its perforation, may be produced by all the

"body of Lamotte, neither wounds, fractures, or contusion; only the "commencement of putrefaction of the epidermis, of the papillary and "mucous substance of the face, neck, upper part of the breast, and "shoulders. After having opened the body, we perceived the stomach "excessively distended; on its exterior, we found the coats slightly in- "flamed here and there, but decidedly so towards the pylorus and duo- "denum: the small intestines very much distended, the large ones in their "natural state. Having removed the stomach, we found the spleen gorged "with blood, and nearly twice its natural bulk; the liver likewise ex- "tremely bulky, gorged with blood, its parenchyma preserving its natural "colour and consistence; the membranes only which envelop its convex "part, and the portion of the diaphragm which invests them, gangrenous "and without adhesion; the lungs distended with blood, the base of the "inferior lobe of the right lung inflamed, in parts adhering and gangrenous: "the heart withered, shrivelled, and containing no blood; the œsophagus "slightly reddened, without tumefaction, on the internal surface of its "inferior part."

"On opening the stomach, we found in it a few spoonfuls of a reddish "brown matter, of the consistence of a jelly, very clear; its villous mem- "brane black in waves, burnt, destroyed, and dissolved, coming off by the "finger as a mucus which had been applied over its nervous coat; which "last, by reason of its whiteness, appeared to us to be sound, at least for "the greatest part; the membranes of its smaller extremity were greatly "inflamed, and covered with gangrenous spots; and the pylorus itself "shrunk.

"We opened the duodenum, and about two feet of the jejunum; their "villous coat was found less dissolved and destroyed than that of the "stomach, and covered with the same reddish brown substance as was "found in that viscus, but more viscid and tenacious. We made incisions "here and there into the *jejunum* and *ileum*, where the same appearances "presented themselves, but less decided in proportion to their distance "from the stomach. The great intestines, from the *cæcum*, were found "full, and lined with fecal matter, which appeared glairy and yellowish. "The mesentery, the kidneys, the *capsule of Glisson*, were found nearly in "their natural situation." (*Recueil Périodique de la Société de Méde- cine*, tom. vii. p. 343, et seq. ou *Ancien Journal de Médecine*, tom. liii. p. 15.)

corrosives. 2dly, That the mucous membrane of the stomach may be detached by a great number of these poisons. 3dly, That the gangrenous patches of the integuments may equally belong to all the poisons which act with very great activity.

We are under the necessity of acknowledging, that it appears to us impossible, in the present state of science, to point out in a precise manner, the seat, extent, and character, of the lesions produced by corrosive sublimate.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE VARIOUS CASES OF POISONING BY CORROSIVE SUBLIMATE.

67. All the ideas, whether chemical, physiological, or pathological, which we have already considered in the different articles on corrosive sublimate, ought to be taken advantage of by the practitioner, who finds himself under the necessity of deciding, whether poison by this salt has taken place or not. Whether called to the assistance of the patient, or required to instruct the magistrate, it is to these principles he must have recourse, to avoid compromising the lives of persons committed to his care, his own reputation, and that of persons who may be unjustly accused of so horrible a crime.

We shall in this article point out the line of conduct which the physician ought to pursue in these instances; and in order to leave nothing undone in this particular, we shall investigate in succession all the cases which can possibly present themselves.

1st, The physician may be called in, whilst the patient is still living, and the remains of the poison are found upon him, or in his house, whether in a liquid or a solid state, alone, or mixed with some plaster.

2nd, A second case which may occur, is that in which the patient is tormented with stools and vomitings, the matter of

which has been preserved, without being able to procure any of the poison, the whole of which has been swallowed.

3d, The patient still living; no possibility of procuring the vomitings or stools.

4th, lastly, He may be dead.

FIRST CASE.

The Person is living; the Remainder of the Poison can be procured.

68. The situation of the patient; the information he can furnish respecting what has passed; the report of the assistants; and above all the chemical examination of the substance with which he is supposed to be poisoned. These are the numerous resources which the person called on to determine, has in his hands.

A. If this substance be liquid, and in very small quantity, a few drops of it should be taken up in the end of a quill, cut for the purpose, or in a small glass tube, and dropped upon some paper of tournesol, or on a plate of copper, perfectly freed from impurities. It should be tried successively in the concentrated solutions of hydro-sulphuret of ammonia, nitrate of silver, caustic potash, or carbonate of potash, of ammonia, of prussiate of potash, and syrup of violets. All these tests will produce the results we have pointed out in speaking of the solution of corrosive sublimate, from § 32, to § 42: and the physician may decide boldly that it is this salt. If, however, after having made all these experiments, there should still remain a portion of this solution, it should be mixed with potash, and evaporated to dryness in a small capsule of porcelain; the dry residue should be detached, put into a small glass tube *(fig. 1)* and gradually heated to redness. Metallic mercury in globules, will be quickly obtained (§ 30). The potash must not be neglected to be added before beginning the evaporation: without that, a part of the sublimate would be volatilized and lost (§ 33). Lastly, if the quantity of fluid

would permit the making another essay, it should be brought in contact with a plate of zinc, which would decompose it, as we have observed (§ 46.).

B. If this liquid substance be mixed with milk, soup, tea, wine, syrups, &c. it may happen that these mixtures may be a little turbid, without offering any very distinct sediment. They may, on the other hand, be perfectly clear, and present a sediment collected together at the bottom: these effects depend, as we have shewn above, upon the quantity of sublimate employed. In these cases it happens, either that the fluid will present the phenomena we have just described with the agents (A), or its precipitates will be modified by its mixture with these different substances. If there be a precipitate, metallic mercury may be obtained by calcining it in a small glass tube, after having dried it upon a filter, or in a capsule of porcelain. (§ 57.)

C. If this salt be in a solid state, the examination should be begun by observing whether it appears under any of the forms pointed out § 25, and afterwards a portion of it should be heated in a glass tube with potash. In the space of five minutes, globules of metallic mercury would be obtained: in the place of potash, metallic antimony may be employed; and the remainder may be afterwards dissolved in distilled water, filtered, and brought into contact with all the tests of which we have spoken. If, however, the quantity of the salt be extremely small, it will be better to make one solution of the whole.

D. If the salt be in a state of solidity, and form part of a plaster, it will be best to cut it up in small pieces, and boil them a quarter of an hour in distilled water; this fluid, after standing awhile, should be filtered, and examined as we have pointed out; it is clear, that if the corrosive sublimate be neither decomposed, nor strongly retained by the materials which compose the plaster, it ought to be found in solution in the fluid; the nature of which would be discovered by the tests above enumerated. If the distilled water does not contain a

particle of this salt, then the whole solid portion should be dried in a capsule and mixed with potash: after this it should be put into a glass retort to which should be adapted a receiver with a long neck, and made red hot, taking care to increase the heat gradually: by this means will be obtained metallic mercury in globules, adhering to the sides of the neck of the retort, mixed with a thick blackish oil. It may probably happen that the quantity of metallic mercury obtained, is so small, and divided over so large a surface, that it escapes the most attentive search, especially when the inside of the neck of the retort is blackened by the oil and charcoal: in this case it must be broken into small fragments, which are to be cleaned with nitric acid perfectly pure, at about 24 degrees. This acid will dissolve the whole of the mercury, and reduce it to the state of nitrate at minimum easy to recognise by the red, white, and black precipitates formed by the chromate of potash, muriatic acid, ammonia, and the hydro-sulphurets (§ 16. C).* The existence of metallic mercury, easily established by these means, does not, however, strictly prove that the plaster contains corrosive sublimate, since in order to prove that, it will be necessary to obtain the muriatic acid. It is nevertheless of no consequence; the juridical physician can always safely affirm that the symptoms have been produced by a mercurial poison, which may be an oxyde, a nitrate, a muriate, &c. Otherwise by submitting the plaster to the action of caloric by means of the apparatus described, § 50, it will be easy to demonstrate the existence of the muriatic acid it may contain.

Second Case.

The Person is living: all the Poison has been swallowed: the Matter vomited can be examined.

69. This case, much more difficult than the preceding, is one of those which most commonly occur in this kind of

* If the nitric acid contains muriatic acid, as generally happens in the

poisoning: it is necessary therefore to pay particular attention to it.

A. If the matter vomited be fluid, without any mixture of aliments, not very thick, and, after being filtered, with the tests mentioned § 68, it affords the precipitates there described, it may be concluded that it contains sublimate. But if some of these precipitates should be wanting, or present themselves under a different colour, the fluid should be mixed with caustic potash, and evaporated in a capsule of porcelain to perfect dryness: it should then be detached, and made red-hot, in a small glass retort, to which a balloon is adapted: if then metallic mercury is obtained in the neck of the retort, it may be decided that a mercurial poison has been used. The same thing might be determined, where no globules are perceived, provided that the fragments of the neck of the retort, being treated without heat by the nitric acid at 24°, give out a liquid containing nitrate of mercury at minimum, which may easily be ascertained (§ 17. C.). This is the only good method of analysing the fluid vomited.

If any one should confine himself to the use of the tests we have mentioned, he might be led into error. In fact, it is not unusual to obtain gray precipitates more or less dark, instead of those white, yellow, &c. The fluid is often coloured, and turbid to such a degree, that it is impossible to decide whether there is any precipitate, much more to determine the colour of it. Sometimes these depositions take place with great difficulty: this effect depends at the same time on the great quantity of the vehicle in which the poison may be diffused, and the union it may have contracted with the different substances contained in the stomach, such as wine, soup, bile, &c.

B. If the matter vomited is at the same time both fluid and

acids of commerce, the experiment will fail, because, as fast as the nitric acid dissolves the mercury, it would be thrown down in a white precipitate by the muriatic acid.

solid, it must be expressed through a piece of fine linen, and the solid part must be preserved in alcohol, to keep it from putrefaction: after which the fluid part must be examined in the manner we have pointed out; and if the existence of mercurial poison cannot be ascertained, the solid part must be submitted to examination by drying and calcining it in a retort, in order to obtain the metallic mercury.

By recollecting with what facility albumine, milk, soup, and other alimentary substances, convert sublimate into the muriate of mercury at minimum, it will readily be seen, why, under certain circumstances, it is impossible to discover this salt in the fluid substances.

70. M. Chaussier perfectly understood this remarkable fact; for, in speaking of the decompositions of which the sublimate is susceptible, he points out the process necessary to be pursued when it is no longer to be found in the fluid, and has been transformed into mercurius dulcis. "If the decomposition," says he, "were less advanced, if the salt be reduced only to the state of a sub-muriate, or calomel, it may still be known by its insolubility in water, and the blackish colour which it would contract by the affusion of lime-water."*

Such are the means this philosopher recommends to be put in practice in order to resolve this important problem. Those which we have proposed appear preferable. In short, it may happen,—1st, that the solid matter vomited, may be of a blackish colour; in this case no change will take place on the affusion of lime-water: 2nd, that the solid matter vomited may be of a white colour, and preserve this colour even when left for several hours in this alkali. I made a paste of bread, boiled french beans, soup, and corrosive sublimate: this salt was instantly decomposed, and formed into a muriate at minimum: on being allowed to remain quiet, an abundant precipi-

* Consultation Médico-légale sur une Accusation de'empoisonnement par le Muriate de Mercure sur-oxydé. p. 146.

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tate was collected: this was carefully washed and preserved in alcohol for eight days: at the end of this time it was of a beautiful white colour. The alcohol was separated and decanted, and a great quantity of lime-water was poured upon the mass: four and twenty hours afterwards, the colour had not at all changed. I made a dog eat the same aliments; five minutes afterwards, I introduced into his stomach twenty grains of corrosive sublimate in solution; the animal immediately vomited all he had taken. The solid matter vomited, perfectly cleansed and put into lime-water, preserved its white colour, even at the end of four and twenty hours. Nevertheless, in both these experiments, these pastes, treated in the manner I have pointed out § 63. A, have furnished me metallic mercury in globules, or nitrate of mercury at minimum; which proves that they contained a mercurial substance. In another instance, a paste made with whites of eggs, meat soup, and herb soup, roasted apples, tea, sugar, and sublimate, furnished a grayish white substance, which was carefully washed, and on which lime-water being left forty-eight hours, produced only a slight change of colour, causing it to become somewhat deeper.

It appears then, that the muriate of mercury at minimum, is capable of forming a strong union with alimentary substances; and that lime-water, at the ordinary temperature, cannot decompose it. Potash is equally incapable of effecting it; neither of these pastes became black on coming in contact with this alkali, although their colour became a little deeper; but after boiling them a little time, the whole compound became black.

Even when from the affusion of lime-water, the insoluble paste becomes extremely black, we cannot be sure that this effect is the result of the decomposition of the muriate at minimum. A simple change of colour is too vague an appearance, to enable any one in consequence of it, to pronounce with certainty, that poisoning has taken place. If added to

this appearance, the matter so blackened, on being treated with cold nitric acid at 24°, should give out to this acid the black oxyde of mercury which produced its colour, and that a nitrate at minimum should be formed, colourless, and yielding a black precipitate to the hydro-sulphurets, a red to the chromate of potash, a white to the muriatic acid, and a black to ammonia; then indeed, it would possess all the character necessary to warrant an assurance, that the corrosive sublimate had been reduced to the state of mercurius dulcis.

71. Before concluding this article, I believe it will be well to give the experiments which I had occasion to make on the matter vomited in the case before mentioned, of M. B., who was poisoned by corrosive sublimate, and on whom I attended.

The quantity of matter on which I had the opportunity of trying the experiments, was about six pints; it contained some aliments greatly changed, and scarcely recognizable; the liquid part was greenish, turbid, of very little consistence, and acid. Being decanted and filtered, it furnished no precipitate properly characterized, with the tests which act powerfully on corrosive sublimate; the hydro-sulphuret of ammonia alone deepened a little its colour, which made me presume that it might contain some mercurial salt. I added about a drachm of potash of commerce, and evaporated the whole to dryness in a capsule of porcelain: the product obtained was blackish, and was found to weigh about five ounces, two drachms. I introduced it into a tubulated glass retort, to which I adapted a receiver: the retort was heated to redness for about half an hour, which produced the decomposition of the animal matter. When the whole was cooled, I broke the glass, in order to discover if there were any mercurial globules; I could not possibly perceive any, but I observed that many of the fragments were crusted with a coat extremely tarnished, and whitish, which I instantly recognized for metallic mercury extremely divided. All these fragments, bedaubed as they were

with carbonated oil, I digested in nitric acid perfectly pure, and obtained a fluid slightly coloured, which gave a black precipitate with the hydro-sulphuret of ammonia, a red one with the chromic acid and the chromate of potash, white with the muriatic acid, and black with ammonia. These facts proved to me incontestably that M. B. had taken a mercurial poison.*

THIRD CASE.

The Person is living: the whole of the Poison has been swallowed: the Matter vomited cannot be examined.

72. Here chemistry affords no resources; consequently it becomes impossible to affirm that poison has been taken. Nevertheless the situation of the patient, his temperament, age, profession, way of life, the manner in which the disease made its attack, its progress, intensity, and duration, the season, the character of the prevailing diseases, &c. may furnish some data capable of enlightening the physician in the diagnosis of so difficult a case.

FOURTH CASE.

The Person is dead.

73. We suppose that there is nothing remaining of the poison, nor of the matter vomited. The only means to which the physician can in this case resort, are the dissection of the body, and a chemical analysis of the contents of the alimen-

* The nitrate of silver likewise gives a white precipitate with the muriatic acid, reddish with the chromic acid, and black with the hydro-sulphurets. On the first inspection, one might be likely to confound this salt with the nitrate of mercury at minimum, obtained in the analysis in question. But we should take notice, First, that ammonia does not precipitate the nitrate of silver, whilst it gives a black precipitate with the nitrate of mercury. Secondly, That the nitrate of mercury in question, has been prepared with a metal obtained in the neck of the retort, and consequently volatile at no great temperature; which circumstance entirely excludes the idea of the silver, a metal which only becomes volatile at a considerable degree of heat.

tary canal, and of the coats of that canal. I shall, in a separate article, point out all the steps to be taken in order to examine properly a body suspected to be poisoned; here I shall content myself by observing, that it is indispensably necessary to make tight ligatures on the middle part of the œsophagus, on the rectum, and on the vessels found on the intestinal surface of the liver, in order to be able to remove the whole digestive canal, without spilling any of its contents. This canal being thus removed, should be opened throughout its whole extent, and the fluids and solids contained in it should be collected in proper vessels; the whole internal surface should then be washed with distilled water, which should likewise be preserved: the lesions throughout its whole extent should be noted, and all the inflamed portions detached with a scalpel, likewise the eschars, gangrenous portions, &c. If there are any perforations, the parts round the holes should be taken out, and all the solid portions preserved in alcohol.

Having collected the different substances, we proceed to their analysis; and first observe if there be any fragments of corrosive sublimate. If any, they must be tried by the means pointed out § 68. C; if none, the fluid must be examined in the manner laid down § 69. A; lastly, if the sublimate has been transformed into insoluble muriate at minimum, and is combined with the alimentary mass, metallic mercury will be obtained from this mass, by drying it and exposing it to the action of caloric. If all these means fail, the portions of the canal preserved in alcohol, must be analysed. After drying them, they should be mixed with a little potash in order to calcine them in a retort, to obtain the metallic mercury. The following are the experiments I have made in order to establish the possibility of recognizing the poison when combined with the human texture. 1st. A portion of the intestine of a cock was perfectly washed, and put into a solution of corrosive sublimate. At the expiration of three days, the fluid was turbid, and became milky; the animal matter acquired a

greater degree of hardness, and lost its coherence without presenting any sign of putrefaction. It was boiled in water, in order to clear it from excess of corrosive sublimate: in this state it was dried in a capsule of porcelain, and afterwards calcined in a retort. Globules of mercury were soon afterwards seen condensed in the neck of the vessel. 2nd. Into the stomach of a rabbit, which had been two hours dead, a drachm of sublimate, dissolved in two ounces of water, was injected. Three days afterwards this viscus was opened, the mucous coat was found strongly corroded, and was very easily torn. It was then taken out and washed in water to cleanse it from the excess of sublimate, when it was dried and submitted to the experiments just related, and metallic mercury was obtained. It is unnecessary to remark, that in these experiments, the digestive canal acts upon the sublimate like all other animal substances: muriatic acid is disengaged, and muriate of mercury at minimum formed, which combines with the substance of the texture. It may be objected, that this chemical action does not take place in the living animal; that our texture, while endued with the vital principle, is not subservient to the same laws as inorganic substances. I know not to what extent this objection is well founded; but, admitting the justice of it, the conclusion is not less true, that if the stomach contains corrosive sublimate at the moment of death, this substance will, from that moment, act on the texture of the viscus itself, in the manner we have seen take place in that of the cock and the rabbit. The effects of this action will be scarcely sensible if the stomach contains a considerable quantity of food, but, on the contrary, they will be very easy to ascertain, if this viscus be empty, and especially if the examination of the body takes place several days after death. It is extremely probable, that the body of M. de Lamotte, jun. which was opened sixty-seven days after death, would have furnished metallic mercury by the process we have pointed

out (§ 66, *note*), if this young man had really been poisoned with corrosive sublimate.

TREATMENT OF POISONING BY CORROSIVE SUBLIMATE.

74. Before entering upon the means which should be employed in the cure of this kind of poisoning, we shall proceed to resolve the following question, which appears to us to be extremely interesting.

" Is any counter-poison to corrosive sublimate known?"

Navier, in his work on counter-poisons,* determines in the affirmative, and points out several substances which he looks upon as antidotes to this salt; for instance, the alkaline salts and earths, the sulphurets of potash and of lime, the martial alkaline tinctures, and the spa waters. I have undertaken a series of experiments in order to establish the utility of these agents, considered as antidotes, and the results I have obtained annul the assertion of Navier. This circumstance arises from the different manner in which each of us have considered this matter.

The physician of Châlons draws his conclusions from facts purely chemical; mine result from a number of experiments made on living animals.

Before going into the detail of these counter-poisons, I think it best to make known the qualities which any chemical agent ought to possess, in order to act as such.

1st. It ought to be such as may be taken in a large dose without any danger.

2nd. It ought to act upon the poison, whether it be in a fluid or solid state, at a temperature equal, or inferior to that of the human body.

3d. Its action ought to be prompt.

* Contre-poisons de l'Arsenic, du Sublimé Corrosif, &c. tom. i. p. 188, 1777.

4th. It ought to be capable of combining with the poisons, in the midst of the gastric liquors, mucous, bilious, and other fluids, which may be contained in the stomach.

5th. Lastly, in acting upon the poison, it ought to deprive it of all its deleterious properties.

75. M. Renault, in a dissertation on the antidotes to arsenious acid, after having pointed out all these qualities,* insists upon the necessity of trying upon living animals the different agents proposed as counter-poisons, and of obliging them to remain in the stomach with the poisonous substance, to the end that nothing may be expelled by vomiting. In short, how can we be assured that an animal, which has taken a strong dose of poison, owes his preservation to a counter-poison given him, if both one and the other are thrown up?

ANTIDOTES TO CORROSIVE SUBLIMATE PROPOSED BY M. NAVIER.

76. Alkaline salts and earths, recommended by this author, ought to act in the stomach by decomposing the corrosive sublimate; and by setting at liberty the oxyde of mercury at maximum; consequently, if this oxyde be a poison, these alkalies will be of no kind of use.

Experiment.—Four grains of corrosive sublimate dissolved in an ounce of distilled water, were precipitated by an excess of carbonated potash of commerce (salt of tartar).

The yellow oxyde precipitated was perfectly washed and cleared from the muriate of potash: it was then given, in a

* Nouvelles Expériences sur les Contre-poisons de l'Arsenic; dissertation soutenue à l'ecole de Médecine, an. 10. p. 3.

I have purposely omitted mentioning one condition stated by M. Renault, which does not appear to me correct. He says, "that counter-poisons ought to be soluble in water, and in the animal fluids." Now, it is evident, that magnesia, which is allowed by all practitioners to be the best antidote to mineral acids, is an earth insoluble in water.

little water, to a dog of middle size. Two minutes after a vomiting came on of a thick yellowish matter, in which was perceived a portion of the oxyde. There was no appearance of any pain. Ten minutes after, extreme dejection was observed, the animal was motionless; fresh vomitings of a white frothy matter succeeded, mixed with inspissated saliva, which was rendered with difficulty. These vomitings continued during an hour, with general insensibility. Eighteen minutes after, death took place, preceded by a trembling of the voluntary muscles. The stomach contained only a part of the oxyde administered, with a very small quantity of fluid. The mucous coat was inflamed throughout its whole extent, without exhibiting any gangrenous spots: the intestines and other organs were sound.

The same quantity of sublimate, mixed with potash, was given to another dog, and the results were the same. Soda and lime acted in the same manner as the salt of tartar. We must, then, conclude, that the alkalies cannot be the antidotes of sublimate, since the yellow oxyde of mercury, in a very small dose, acts as a poison, even when the animals shall have vomited a part of it.

Navier himself does not seem to attach much importance to these agents, as he says, in speaking of the oxyde of mercury, "Now this precipitate is not entirely exempt from corrosion; therefore, the method of correcting the deleterious action of sublimate by alkaline salts being insufficient, it will be prudent to adopt some other, more efficacious, if possible."*

77. The alkaline sulphurets are recommended by the physician of Châlons, as an infallible method of curing those who have swallowed corrosive sublimate. "This salt," says he, "will be entirely decomposed, and converted into a black insoluble sulphuret of mercury."

Experiment.—Twenty-two grains of black sulphuret of

* Op. Citat. tom. i. p. 192.

mercury, dry, and reduced to a fine powder, were given to a middle-sized dog. The animal died twenty hours after, without exhibiting any other symptom than sharp pains in the abdomen, and convulsive movements. These symptoms did not appear till sixteen hours after the exhibition of the poison. On opening the body, the stomach was found to contain some alimentary matter, and a little sulphuret of mercury. The mucous coat of this viscus was for the most part inflamed. No alteration appeared in any of the other organs.

Experiment. — Fifteen grains of corrosive sublimate were decomposed by the hydro-sulphuret of potash. The black sulphuret which resulted from the operation, was perfectly washed, and administered to a little dog. In five minutes he was much agitated, shewed great signs of suffering, with convulsive movements—no vomiting. At the end of an hour the convulsive movements ceased, he became calm, and died two hours from the administration of the poison. The stomach was found nearly empty, its internal coat covered with the black sulphuret, strongly inflamed, and of a brownish colour; a quantity of mucous matter was found in the bronchiæ. This experiment was repeated with four grains of the sublimate dissolved, and half a drachm of the sulphuret of potash. The result was precisely the same.

Experiment.—Three grains of sublimate dissolved in an ounce of water, were given to a little dog. Immediately after he was made to take thirty grains of the sulphuret of potash, dissolved in three glasses of water. The animal soon felt very great agony, vomited some thick matter of a blackish colour; he died ten hours afterwards. The interior of the stomach was greatly inflamed ; the mucous coat, in the vicinity of the pylorus and of the cardia, was gangrenous ; the œsophagus but little inflamed ; the intestines sound.

These experiments were made on other dogs, substituting the sulphuret of lime for the sulphuret of potash, and the results were just the same. Consequently, these chemical agents cannot be the antidotes of sublimate.

I wished to try what would be the effect of the martial alkaline tincture which Navier speaks of.* I gave two drachms of it diluted with three ounces of water to a dog who had just taken four grains of corrosive sublimate in solution. The animal died six hours afterwards.

The result of all these experiments proves, that the chemical agents, recommended by Navier, are of no use in cases of poisoning by corrosive sublimate in a fluid state. They must consequently be still less so if this salt has been swallowed in a solid form; for the force of cohesion opposes a strong resistance to the chemical action which ought to take place between the poison and its antidote.

EXAMINATION OF OTHER SUBSTANCES PROPOSED AS ANTIDOTES TO THIS SALT.

78. Sulphurated hydrogen gas, hydro-sulphurated water, sugar, infusion of Peruvian bark, metallic mercury, soup, albumine; such are the substances whose action on the corrosive sublimate we have now to examine.

Experiment.—Sulphurated hydrogen gas, and hydro-sulphurated water, decompose corrosive sublimate in the same manner as the hydro-sulphurets; wherefore all the animals, to which I have administered these agents as antidotes to this salt, have perished at the expiration of a longer or shorter time. They ought, then, to be rejected, although latterly recommended by men of distinguished talents.

79. M. Marcelin Duval reports, that after having given to a dog a piece of bacon which concealed twenty-four grains of corrosive sublimate, the animal experienced some symptoms, which he succeeded in relieving, by administering to him a great quantity of sugared water.† I wished to de-

* This tincture is prepared of borax, water, cream of tartar, and sulphate of iron. *Navier*, p. 196.

† Dissertation sur la Toxicologie, soutenue à l'ecole de Paris, 1806, p. 38.

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termine whether this effect depended on the sugar, or on the vehicle with which it was united.

Experiment.—Ten grains of sublimate dissolved in two ounces of distilled water, were given to a middle-sized dog. He was immediately made to eat three ounces of white sugar well pulverized; two minutes afterwards he vomited a great quantity of alimentary matter, experienced violent pains, tossed himself about greatly, and expired at the end of two hours. The stomach was inflamed.

Experiment. — Two ounces of pulverized sugar were given to a rabbit: immediately afterwards it was made to swallow two grains of sublimate dissolved in an ounce of water. An ounce more sugar was then given it. At the end of fourteen minutes it died. These facts prove, evidently, that sugar does not act as an antidote to sublimate, and that the good effects obtained from sugared water, depend on the enormous quantity of the liquid. This will be put out of all doubt by the following experiment.

Experiment. — A dog was made to drink about eight ounces of water; two minutes afterwards ten grains of corrosive sublimate were administered to him, dissolved in six ounces of the same fluid. The animal vomited much. Water was continued to be given to him even when he vomited no longer: at the end of twenty-four hours he was perfectly recovered.

80. M. Chausarel has announced, that he caused ten grains of corrosive sublimate to be given to a dog, and that he was perfectly cured by an infusion of cinchona *calissaya*. The author concludes, from this fact, that cinchona is an antidote to corrosive sublimate.*

Experiment.—The œsophagus of a middle-sized dog was detached from the surrounding parts, and pierced with a

* Chausarel Observations sur diverses Substances Vénéneuses, p. 47, Bourdeaux, 1807.

small opening, through which twelve grains of corrosive sublimate dissolved in two ounces of water were injected into the stomach. One minute after, seven ounces of a strong infusion of cinchona *calissaya* were introduced into this viscus, and the œsophagus was tied below the opening, to prevent vomiting. The animal very shortly after began to make violent efforts to vomit; he lay down, and remained in a state of perfect immobility: an hour afterwards he passed a stool almost liquid, and died at the expiration of five hours.

The inflammation of the mucous membrane of the stomach, was arrived at its highest pitch near to the cardiac portion, and throughout the bottom of this viscus: it was of a blackish red colour; extremely hard, and adhering strongly to the muscular coat: that part which covered the pyloric portion was very red, but much less inflamed. This viscus contained a part of the liquid injected, and a very great quantity of tenacious mucosities.

Experiment.—The same quantity of sublimate was injected in the same manner, into the stomach of another very strong dog. Immediately after, eight ounces of a very strong infusion of the gray cinchona were administered: the animal died five hours afterwards, and very nearly the same alterations were observed, as in the preceding cases.

These experiments prove that the infusion of Peruvian Bark is of no use as an antidote to corrosive sublimate. M. Chausarel gives no account of the symptoms experienced by the animal; he does not say whether the poison was expelled by vomiting; and lastly, it does not appear to us, that a solitary fact, even when accurately stated, ought to suffice to establish a principle of so great importance.

81. We find in an ancient epigram of Ausonius, that a woman gave to her husband some metallic mercury, with the design of increasing the energy of a certain poison, which she had administered to him. Far from producing this effect,

the mercury on the contrary, entirely re-established the health of the person poisoned.

The celebrated Goethe, asks of the Professor Doebereiner of Jena, what was the poison which he had taken. This learned man is of opinion, that it was corrosive sublimate, since, of all the poisons known, it was the only one whose power was weakened by mercury.

It appeared to me worth while to try some experiments to throw a light on this fact.

1st. A drachm of metallic mercury was given to a rabbit; immediately afterwards, it was made to take three grains of corrosive sublimate, dissolved in two ounces of water: the animal experienced a trembling all over the body, and died thirteen minutes after.

2nd. Ten grains of liquid sublimate were swallowed by a very strong dog: one minute afterwards, a drachm of metallic mercury was administered to him, and he was muzzled. He suffered much, and died in a quarter of an hour. The stomach presented no sign of inflammation: it contained about two ounces of fluid, a very little solid matter, and metallic mercury tarnished by a slight crust of muriate at minimum. The fluid consisted partly of the sublimate not decomposed. It appears from this experiment, 1st, that a portion of the corrosive sublimate was decomposed by the metallic mercury, and converted into muriate at minimum. 2nd. That another portion of this salt was not decomposed, and exerted its poisonous action. 3rd. That it is impossible that the whole of the poison can be decomposed, for these reasons, because, the metal being very heavy, occupies the bottom of the stomach, and does not come in contact with the fluid; and further, because it ceases to exert its action, as soon as it is covered with the first coat of muriate of mercury at minimum. 4th. Finally, that it ought not to be considered as the antidote to corrosive sublimate.

82. Broth does not decompose corrosive sublimate with

sufficient energy, to be considered as an antidote to this poison. Nevertheless, the dogs to which I gave ten or twelve grains, and who afterwards swallowed five or six ounces of broth, lived longer than those which swallowed the sublimate only.

83. The facility with which albumine decomposes corrosive sublimate, the nature of the precipitate resulting from this decomposition (§ 50), and which appeared to me not to be very hurtful; in fine, the desire of finding a counter-poison amongst the substances in most frequent use, and within the reach of every one, are the considerations which induced me to ascertain by experiment, whether the white of eggs be not an antidote to that poison.

Experiment 1st. Sixty grains of the precipitate obtained by means of albumine in a solution of corrosive sublimate were given in powder to a middle-sized dog, who experienced no inconvenience. The same quantity of this precipitate well washed, and in a jelly, was given to a rabbit, from which likewise, no apparent inconvenience resulted. Another weakly dog, who had already swallowed, a few days before, a small dose of sublimate, took sixty grains of this precipitate in the form of jelly: he twice vomited up a whitish matter, without any appearance of suffering pain, and perfectly recovered.

Experiment 2nd. I diluted the whites of six eggs in four ounces of water: the fluid resulting from it was filtered, and mixed with twelve grains of corrosive sublimate dissolved in two ounces of water. The decomposition of the sublimate immediately took place; and I made myself certain that the whole of the salt was decomposed by the above quantity of albumine. The compound was injected into the stomach of a middle-sized dog, and I prevented his vomiting, by passing a ligature over the œsophagus: the animal made great efforts to vomit, and appeared greatly incommoded; an hour after he passed a stool almost liquid. At the end of four and twenty hours he began to flag; he had an ardent thirst, and the pulse

beat a hundred and twenty strokes in the minute. I loosened the ligature from the œsophagus, which was a great deal too tight: he drank a vast quantity of water. The next day he continued nearly in the same state, and died three days after the injection.

The stomach and intestinal canal were perfectly sound; they shewed no traces of inflammation: the œsophagus was violently inflamed, and almost in a state of gangrene, for near an inch about the ligature: where the thread was applied, it was nearly cut through.

Experiment 3rd. Twelve grains of corrosive sublimate dissolved in an ounce of water, were introduced by means of an elastic gum catheter into the stomach of a little dog: at the expiration of eight minutes he had thrice vomited a thickish matter, of a violet colour, and in small quantity. The whites of eight eggs beat up with two ounces of water were then injected, part of which was immediately vomited; a few moments after he vomited again, and the matter thrown up was white, turbid, and exactly resembled the triple body which results from the mixture of albumine and corrosive sublimate. Five days afterwards, the animal, which suffered but little, was quite recovered.

Experiment 4th. Twelve grains of corrosive sublimate, dissolved in two ounces of water, were given to a middle-sized dog; immediately after three whites of eggs beat up with three ounces of water were injected, and the œsophagus was tied to prevent vomiting. The animal made great efforts to vomit: twelve hours afterwards, he died with all the signs of having been poisoned by sublimate. The mucous coat of the stomach was strongly inflamed, especially towards the cardiac portion; it was blackish and very hard; that part which covered the duodenum and pylorus was injected in a very sensible manner.

Experiment 5th. Twelve grains of corrosive sublimate in a fluid state, were mixed with two whites of eggs, beat up with

four ounces of water. This mixture was given to a very strong dog, which was afterwards muzzled: horrible sufferings, vomitings of a white matter, very thick, and abundant stools with an extreme degree of agitation, were the symptoms which preceded death, which took place two hours after.

On opening the body, the stomach was found to contain very little liquid matter, was strongly inflamed on its internal surface, without any signs of gangrene; the mucous coat of the intestines was perfectly sound.

Experiment 6th. Two rabbits, to which had been given two grains of corrosive sublimate dissolved in an ounce of water, and mixed with the white of one egg diluted, died four minutes after swallowing the mixture.

CONCLUSIONS DRAWN FROM THE EXPERIMENTS MADE WITH ALBUMINE.

There results from these experiments, and from many other similar ones which I purposely omit mentioning, 1st, that the triple body composed of albumine, muriatic acid, and the oxyde of mercury at minimum, may be taken without danger in a large dose (*Experiment* 1st.); 2nd, that when a very great quantity of the white of egg is given, previously mixed with the corrosive sublimate; the deleterious action of this poison is hardly sensible. The animal which forms the subject of the 2nd *Experiment*, and which died in consequence of the very severe inflammation of the œsophagus, justifies this conclusion. If the action of the twelve grains of sublimate, which he took with the albumine, had not been considerably diminished, death would have ensued within a few hours from the injection; and the stomach would have shewn signs of inflammation of its mucous coat, more or less intense. 3rd. That dogs who have swallowed twelve or fifteen grains of sublimate, and have been allowed to vomit, seldom lose their lives when the white of eggs diluted with water is given

to them; which circumstance depends upon the power of the albumine, for decomposing the portions of this salt, which it may find in the stomach (*Experiment* 3rd.). 4th. That all animals, which do not take a sufficient quantity of the white of eggs, die in the course of three or four hours, when they have only taken twelve grains of sublimate: which agrees with what we have laid down § 50. i. e. "that corrosive sublimate, mixed with a moderate quantity of albumine, furnishes a fluid in which there still remains sublimate, which consequently, ought to exert its poisonous qualities." 5th. Lastly, That of all the substances hitherto proposed as antidotes to corrosive sublimate; albumine swallowed in sufficient quantity, is the only one useful, because it can be taken with impunity; because it forms with the poison, a body by no means deleterious; lastly, because it is within the reach of every body, and can be applied immediately after the swallowing of the poison.

84. We shall now point out the steps the physician ought to pursue in this kind of poisoning.

From the first appearance of the symptoms denoting it, the patient should be made to swallow several glasses of white of egg beat up with water: if this substance cannot be procured, a decoction of Linseed, of Marshmallow root, or Mallow-leaves, may be given; or rice-water, sugared-water, gelatinous broths, or even common water at the temperature of 25°. to 30°.: by these means the energy of the sublimate will be weakened, and the stomach filled with liquids. The fulness of this viscus will determine vomiting, and consequently the evacuation of a certain quantity of the poison. The patient should be made to drink copiously, so long as the vomitings continue, and until the symptoms are considerably relieved. If the patient be so organized that he cannot vomit, or if he be affected with *Trismus* or lock-jaw, we must then be obliged to have recourse to the method proposed by Boerhaave, and brought to perfection by M. M. Dupuytren and

Renault, which consists in mechanically evacuating the stomach by means of an elastic gum tube, armed with a syringe. "The elastic gum tube," says Mr. Renault, "should be so "long, that one of its extremities may be plunged into the "very lowest part of the stomach, and of a sufficient diameter "to admit the passage of soft substances, such as those which "are half digested: it ought to have two terminal orifices, and "lastly, it should be mounted with a ferule of metal at its ex- "terior extremity, which should be received into the pipe of a "syringe. Things being thus prepared, the catheter should "be introduced by the mouth, or the nostrils, the syringe "adapted, and a certain quantity of fluid should be gently in- "jected, in order to dilute, suspend, or dissolve the poison. "The piston should then be withdrawn, a vacuum formed, "and a certain quantity of the matter contained in the sto- "mach drawn up. When this operation has been several "times performed, this viscus is well washed, and the whole "of the poison extracted without any violence, almost without "pain, and in a very short space of time. Whenever the "poison has not passed the pylorus, and it is not in large "pieces, the possibility of extracting it by those means, is "evident to all those who know any thing of physics. When "experiments upon men shall have proved its efficacy, the "employment of it may become extremely extensive: until "such experiments shall have decided it, I shall offer the fol- "lowing, which I have made upon living animals. I injected "eight ounces of water into the stomach of several small "dogs, and have always succeeded in drawing it all off by the "means above described. It cannot indeed fail to succeed, "if we consider how effectually similar means have been em- "ployed for emptying the bladder of coagulated blood."*

85. I shall report an observation communicated to me by M. Cullerier, which proves to a demonstration, how advan-

* Op. Citat. page 94.

tageous it is in the cases of poisoning here considered, to ply the patient with quantities of fluids.

About twelve years ago, the dispenser, who was charged with the preparation of the solution of corrosive sublimate, employed in the Venereal Hospital, by mistake made use of a larger quantity of sublimate than was proper for preparing the medicine. Two hundred patients under treatment for venereal complaints, took a portion of this fluid, and were poisoned by it. Rending pains at the stomach, and over the whole abdomen, copious vomitings, and a tightness about the throat, were the symptoms which first announced the action of the poison. M. Cullerier, principal Surgeon to this Hospital, being informed of the circumstance, had recourse instantly to mucilaginous drinks. He ordered milk, decoction of linseed, and warm water. He gave to each patient about ten pints of liquids, in the space of six or seven hours; and at the end of this time, the symptoms had nearly all vanished: ten or twelve only of the patients still felt pains of the stomach for twelve or fifteen days; but none of them died. It was a curious circumstance, that the pains were more severe, in proportion as the stomach was more empty; and were hardly felt immediately after the ingestion of the liquids. M. Cullerier is ignorant of the dose of corrosive sublimate which might have been given to these patients; but he is of opinion, that the least was two or three grains.*

* The Ancients had already noticed the advantages resulting from vomiting in cases of poison; Dioscorides in his book on poisons, recommends water, oil, and butter, as vomitives. Matthioli thus reports the passage of that author:

" Quod si qui forsan obmutescentes, aut temulenti, aut nolentes alioqui " venenum a se egeri, nullam nobis ejus cognitionem præbeant, tum pro- " tinus accedendum ad ea quæ communiter epotis quibuscunque venenis " opitulari consueverunt. Atqui nullum magis in omnia valens auxilium " dari potest, quam ut proximo loco virus foras exhauriatur, priusquam " invalescat. Quare sine morâ calidum oleum ex aquâ, aut seorsum ut " vomitare cogantur, dari convenit. Aut si oleum natura loci negat, buty- " rum cum aquâ calidâ, aut malvâ, aut lini semine, aut trago, urticâ, fœno-

86. Copious and mucilaginous drinks ought to be preferred to any other emetics, in order to excite, or encourage vomit-

" græco, aut halicæ decocto, vicem ejus exhibebit. Hæc enim non modo " vomitionibus exigent vi illâ suâ laxatrice, aut nauseam ciente : sed alvum " quoque subducent, et corporum inanitione ita adversabuntur, ut acrimo- " nias venenorum hebetent." (Petri Andreæ Matthioli, Venetiis, 1558, lib. vi. page 711.)

Ambrose Paré says, " And if a man suspects that he has taken poison by " the mouth, he ought not to sleep in such a case ; for the force of the " poison is often so great, and it is so inimical by nature, that it will exert " its power : that often it produces the same effects on our bodies, as a fire " kindled amongst dry straw; for oftentimes it happens, that those who are " poisoned, before they can have the assistance of a physician or surgeon, " die. They should then instantly be made to vomit, by taking oil and " warm water: instead of oil, they may take melted butter, with warm " water, or decoction of linseed, or fenugreek, or some fat broth ; for such " things as these cast out the poison by vomiting ; added to which they re- " lax the belly ; and by such evacuations the poison is thrown out, and its " acrimony destroyed." (*Œuvres d'Ambroise Paré, onzieme edition, des Venins*, liv. xxi. ch. vii. p. 485.)

The following observation of Sydenham, has for its object a case of poisoning by corrosive sublimate cured by water.

" Duobus abhinc mensibus quidam in viciniâ me rogabat ut servum in- " viserem, qui haud modicam mercurii sublimati quantitatem deglutiverat. " Hora fere elapsa erat, quâ venenum hauserat, cum ad eum accederem, " jamque os et labia valdè intumescebant. Vehementer ægrotabat ardente " ventriculi dolore, caloreque tantùm non confectus. Ego tres aquæ tepi- " dæ congios, repetitis haustibus summâ quâ potui celeritate et diligentiâ " ebibendos imperavi, atque ut toties nova ingereretur copia, quoties ven- " triculus jam ingestam per vomitum ejecerat: volui etiam ut eluerentur " intestina aquâ tepidâ sine ullo additamento copiosè per sedem injectâ, " ubi primum ventris tormina admonerent venenum jam per inferiora exi- " tum quærere. Paruit miser, jam vitæ avidus, et plures etiam aquæ li- " bras quàm præscripseram, absorpsit. Amici, qui ægro utpote in casu in- " solito, assiderent, ab eo didicerunt, quas primum evomuit aquas gustu " perquam acres fuisse, sale scilicet venenato pleniùs exsaturatas; singulis " autem vicibus rejectas aliquam semper acredinis partem amittere, donec " tandem nihil prorsus saperent. Quæ mox urgebant tormina, solâ aquâ " injectâ ad modum enematis leniebantur. Hoc tamen nullo rerum appa- " ratu, benedicente numine, intra paucas horas convaluit æger, nisi quod " labia non statim detumescerent, ore etiam a veneni particulis, quæ aquam " quam evomuerat penitiùs infecerant adhuc exulcerato. Quæ symptomata

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ing, in cases of poison by corrosive sublimate. Indeed these kinds of drink have the triple advantage, of being administered with promptitude, of expelling the poison, and of moderating the irritation already produced.*

It is necessary to keep in mind in administering these kinds of drink, that their efficacy depends upon their quantity; and that consequently, they should be administered to the patient even when he feels no inclination to drink.

87. Oils, and greasy substances in general, are of no kind of use, and ought to be laid aside, because they act in opposition to real solvents.

88. The treatment of this kind of poisoning, ought to be still more active, if the organs of the abdomen are in a state of inflammation. For neither is it uncommon to witness Gastritis, Enteritis, and even Peritonitis, as the consequences of this accident. These cases, generally unfortunate, require on the part of the physician, the greatest attention. If the inflammation be but incipient, general and local bleedings should be had recourse to; by applying, for example, ten, twelve, fifteen, or twenty leeches on the parts in pain. These means perfectly succeeded with me in the case of the patient who is the subject of the first observation, page 51, and I am convinced it may be turned to great advantage. If the patient is strong and vigorous, there can be no fear of one or two bleedings from the arm, in order to counteract, as much as possible, the violent inflammations produced by this poison. The use

" diætâ a lacte solo ad quatriduum adhibitâ mox evanuerunt. Aquam oleo " (quod hic una cum opere ignari solent perdere) atque aliis omnibus liquo- " ribus ideo prætuli, quod cum eâ magis esuriret, exinde magis idonea mihi " videretur devorandis salinis hujus veneni particulis, quam alius quilibet " liquor, qui vel crassior esset, vel particulis alieni corporis jamdiu præg- " nantior." (*Sydenham Opera Medica*, Epist. i. p. 200.)

* " Vomitoria tamen non sint fortiora ac maligna, sed leniora, et cum " periculum sit in morâ, nec semper operosa medicamenta componere " liceat, quæ ad manum sunt vomitoria exhibere donec alia parentur, ne- " cessarium est ex aquâ tepidâ." (*Sennert. Opera*, tom. iii. p. 616. Lugd. 1760.)

of emollient and anodyne glysters, in these cases, affords unquestionable advantages. They may be prepared with a decoction of marshmallow-root, linseed, and laudanum.

It is essential not to neglect the application of emollient fomentations over the whole of the abdomen ; they ought never to be omitted, except in cases where the pain is so violent as to render the weight of these applications insupportable. The *Pediluvium*, and even the warm bath ought to be employed; the patient may remain in it several hours, provided that the temperature of the water be always nearly the same. In fine, the lowest diet must be prescribed, and the patient allowed nothing but emollient drink.

If the inflammation is already arrived at a certain height, or if it has gone through its several stages, bleeding must be laid aside; for there will be reason to apprehend gangrene: the treatment in this case must be the same as in intestinal phlegmasiæ.

89. Antispasmodics, and even Narcotics, ought to be employed, in cases where there are any alarming nervous symptoms, such as spasms and convulsions.

When the symptoms are relieved, and the patient is entering on a state of convalescence, he ought to be supported with a farinaceous diet, and softening drinks, such as milk, rice-cream, oatmeal gruel, light panada, and broths prepared from the flesh of young animals.

If the poison should have been taken by a person already sick, it is evident that regard ought to be had to the complication in the course of the treatment; and the means must be varied according to the nature of the pre-existing disease.

RED PRECIPITATE, AND PRECIPITATE *Per se.*

90. These two bodies are nothing else but the oxyde of mercury at the maximum of oxydation; the former however almost always contains a little nitric acid.

91. Their colour is red; when heated in a glass tube, they become decomposed, and give out volatile metallic mercury, adhering to the sides of the tube, and oxygen gas, which is disengaged.

92. They are insoluble in water; rubbed on a plate of copper freed from impurities, they render it white, shining, and silvery.

93. The hydro-sulphuret of ammonia blackens them instantly, and converts them into sulphuret of mercury. (§ 17. D.)

94. The muriatic acid of commerce dissolves them very well without heat, and furnishes muriate of mercury at maximum, which yields a yellow precipitate to potash, and a white one to ammonia.

95. When triturated with a solution of alcoholized potash, they never furnish sulphate of potash; which circumstance distinguishes them from *turbith mineral*, of which we shall speak bye and bye.

96. These two preparations ought to be considered (especially the red precipitate) as violent poisons. Plouquet reports, that a man who had been tormented with a violent head-ache, swallowed by mistake, some red precipitate which was contained in a box. He experienced, in a short time, violent colics, copious vomitings, a trembling of all his limbs, and cold sweats.*

Minium, Colcothar, and Kermes, the colour of which approaches that of these mercurial compounds, cannot be confounded with them, since they exhibit appearances altogether different with the tests of which we have been speaking.

OF TURBITH MINERAL.

97. Turbith mineral is a salt formed of a great portion of oxyde of mercury at maximum and a small quantity of sul-

* Plouquet. Comment. Med. in Processus Criminales, p. 165.

phuric acid; for which reason it is likewise known by the names of sub-sulphate of mercury at maximum, sulphate of mercury with excess of oxyde, or sub-deuto-sulphate of mercury. It is in the form of a yellow powder, the shade of which varies greatly, according to the manner in which it is prepared.

98. Being heated in a small glass tube, *(fig. 1)*, it becomes decomposed, and gives out metallic mercury which condenses on the sides of the tube; oxygen gas and sulphureous acid gas, which are set at liberty: it is almost insoluble in water.

99. The hydro-sulphuret of ammonia brought in contact with this yellow salt, immediately blackens it, and converts it into sulphuret of mercury. (§ 17. D.)

100. Rubbed on a plate of pure copper, it renders it white, shining, and silvery.

101. Nitric acid dissolves it easily without heat, and forms a clear colourless solution, which affords a black precipitate to the hydro-sulphuret of ammonia, and a yellow one to the caustic potash; and which is not rendered turbid by the chromic acid. These facts incontestably prove, that the turbith mineral properly prepared, is a salt at the maximum of oxydation. It often happens that the turbiths of commerce dissolve only in part in the nitric acid; and in that case, the portion undissolved is of a beautiful white colour: the turbith then has been badly prepared, and ought to be considered as a mixture of yellow turbith soluble in nitric acid, and of sulphate of mercury at minimum, white, and insoluble in this acid at the ordinary temperature.

102. Turbith, when agitated in a solution of alcoholized potash perfectly pure, is changed into an insoluble yellow oxyde of mercury at maximum, and sulphate of potash which remains in the fluid: so that on filtering it, a liquid is obtained, which gives a white precipitate on the addition of a few drops of muriate of barytes: this precipitate is sulphate of barytes, in-

soluble in water or in nitric acid. The badly prepared turbiths, of which we have already spoken, would give the same results, only that a black oxyde of mercury would be obtained by the affusion of potash: this oxyde would belong in that case to the sulphate of mercury at minimum, decomposed by the alkali.

This preparation, which Boerhaave and Lobb have so highly extolled for preventing the small pox, and which many other physicians have employed as an emetic in the bite of a mad dog, is, at the present day, almost excluded from the materia medica: it is hardly ever used in the venereal disease, or in obstructions; and seldom becomes the object of medico-legal investigation. What we have here said of its nature and properties is sufficient to distinguish it from the other substances with which it might be confounded.

OF OTHER MERCURIAL SALTS.

103. The nitrates and sulphates of mercury at maximum and minimum, the ammoniaco-mercurial muriates, &c. ought to be equally considered as poisons: their history is contained in what we have said in the preceding articles.

MERCURIAL VAPOURS, AND MERCURY IN A STATE OF EXTREME DIVISION.

104. Mercury reduced to the state of vapour ought to be considered as a poison. Fernel, Swediaur, Fourcroy, and others, have given reports of cases, which prove how much the workmen employed in mercurial mines, gilders, silverers of looking-glasses, constructers of barometers, &c. are subject to serious accidents from their calling. The author of the *Système des Connaissances Chimiques* gives us a striking instance of the evils which these vapours are capable of producing, in the history of two persons with whom he was acquainted, which we shall give in this place.

OBSERVATION.

A man was in the habit of gilding from morning to night, in a room sufficiently large, but low; where he slept himself, his wife, and his children. Having taken but little precaution to guard against the effects of mercurial vapours, he was first visited with chancres on the mouth in very great numbers: his breath, at this time, was fetid; he could neither swallow nor speak without dreadful pains. Similar symptoms, cured by cessation from his employment and appropriate medicines, reappeared three or four times in succession, without any other accident: but, in a short time, this evil was accompanied with a very violent trembling, which first attacked the hands, and afterwards the whole body. He was confined to an armchair, not being able to move a single step. His condition was truly pitiable. Agitated by perpetual convulsive movements, he was neither able to speak, nor to raise his hands to his mouth without striking himself. He was under the necessity of being fed, and could only swallow by a convulsive deglutition, which had well nigh choaked him a hundred times. In this situation he had recourse to an empiric, who prescribed several secret medicines, and ordered his legs to be rubbed with some ointment. The effect they produced was remarkable: the tremblings ceased a little, his legs and thighs swelled prodigiously; a great quantity of blisters made their appearance upon them; these were pierced with a needle; they gave out, in abundance, a turbid serum, which was preserved in small pots, by order of the empiric. At the expiration of a certain time, there formed an abscess, in which globules of mercury were manifestly perceived. In the course of five or six months of a similar treatment, the patient felt himself much better: the trembling having nearly disappeared, and scarcely existing at all any more, he considered himself cured, and neglected himself. Exercise strengthened him; but he retained an extraordinary degree of sensibility. The noise of a horse, or any kind of carriage, made him start to that degree, that he

was, in many instances, near being trampled to death, if he had not taken the precaution of walking against the wall and shops. On resuming his work, notwithstanding all his precautions, the trembling returned, and fixed itself in his hands. It is a singular circumstance, that, being in the habit of getting drunk, when in that situation, he could hold his glass without upsetting it, which he was not able to do before he had drank; and he told me that he knew many of his brethren to whom the same circumstance constantly occurred. The precaution which he took, of working but very little, and of carrying off the mercurial vapours by a current of air, exempted him from the cruel evils which he had already suffered: he no longer felt any thing more than a trembling of the hands, and an insupportable stammering. This gilder lived three or four years afterwards, without any other accident of the kind, and died of a fracture of the arm in three different places.

His wife laboured under nearly the same symptoms, but much less serious in the beginning. She was affected in particular with a continual ptyalism, which dried up her body, and reduced her to a skeleton. In the end, this unfortunate woman became asthmatic: the paroxysms of this disease, which at first observed long intervals, became daily more frequent: she had a continual rattling in the throat, but neither spit up nor coughed towards the end of this disease, which continued the same eighteen years: she could neither walk nor stoop down without fear of being suffocated. After being confined to her arm-chair more than a twelvemonth, the symptoms of her asthma becoming worse and worse, she was at length delivered from her evils by a death, happy indeed for herself, but which was terrific in appearance to the by-standers.*

105. On examination of the effects produced in persons exposed to the action of mercurial vapours, we may reduce

* Essai sur les Maladies des Artisans, trad. du Latin de Ramazzani, par Fourcroy, p. 43.

them to the following: trembling and paralysis of the limbs, vertigo, loss of memory, and of the other intellectual faculties; salivation, and ulceration of the mouth; colic, asphyxia, asthma, hœmoptysis, atrophy, apoplexy, death.

We cannot refuse to ascribe to these vapours a powerful action upon the organs of sense and motion; but this action does not appear to us to differ sufficiently from that which other mercurial preparations exercise on the nervous system (§ 62), to warrant us, after the example of M. Fodéré, in arranging, in a separate class, the vapours in question.

106. Ought metallic mercury to be considered as a poison? This question appears to me to have been badly understood hitherto. There are authors who affirm that mercury is endowed with the most mischievous qualities; while others, on the contrary, maintain, that there is no kind of danger in taking a strong dose of this substance.

1st. Zwinger relates, that a man, who was a long time tormented with a dreadful colic, took, on the third day of his disease, four ounces of crude mercury, which at first produced no ill accident; but, on the seventh day, there appeared a flow of saliva very profuse, which continued the next day without swelling of the tongue, or of the glands of the mouth. The ninth day the patient passed the mercury by stool, and was nearly cured. The metal expelled was in its natural state, except a few particles which appeared corroded.*

2nd. Laborde reports the case of a person, who kept in his body, for fourteen days, about seven ounces of metallic mercury; and who was attacked with a profuse salivation, accompanied with ulceration of the mouth, and paralysis of the extremities.†

3d. Paul Jalon speaks of a man, who wore a belt of red cloth in which mercury was inclosed, for the purpose of curing

* Ephemerides des Cur. de la Nature, Decembre 2nd, 1688. Obs. 230, par Theodore Zwinger.

† Laborde, Journal de Médecine, tom. i. p. 3.

the itch. At the expiration of two days he was attacked with pains, aphthæ, and inflammation of the tongue, palate, throat, gums, lips, and the whole cavity of the mouth; so considerable a swelling took place, and a flow of so great a quantity of a viscid humour, that the passages were nearly stopped, and the patient could neither drink, eat, speak, nor scarcely breathe; his face was prodigiously swelled, and livid; in a word, he was threatened with a speedy suffocation. On taking off the belt, it was found to contain mercury and some kind of grease. Bleeding, with purgative glysters, were sufficient to relieve the symptoms in the course of eight days.*

4th. Olaus Borrichius asserts, that a man labouring under ardent and malignant fever, died on the same day that two small bags of linen, filled with crude mercury, were applied to his hands.†

5th. Doctor *Scret* caused a dog to take eight ounces of mercury, mixed with four ounces of grease; no accident occurred: the dog even became more ravenous than usual. ‡

6th. I have often repeated the same experiments upon dogs and rabbits, and with the same results.

7th. Dehaen, and several other practitioners, have administered this metal, without the least inconvenience, in obstinate constipations, the iliac passion, and in certain kinds of hernia; provided that these complaints were not complicated with inflammation of the intestines.

8th. The inhabitants of London and Edinburgh, in the beginning of the last century, used to take with impunity every morning two or three drachms of fluid mercury in four or five ounces of oil, as a preservative against the gout and gravel. §

9th. Mr. *Sue* relates, in the Memoirs of the Medical Society of Emulation, that a person took for a long time two

* Ephemerides des Curieux, Obs. 107. Dec. 2nd, 1687.

† Acta Medica et Philosophica Hafniensia. Vol. v. p. 141. Obs. 52.

‡ Ephemer. des Cur. de la Nature, 1670 or 1678.

§ Des Bois de Rochefort, tom. i. p. 213. Materia Medica, 1789.

pounds of mercury daily, with the design of expelling, by the anus, a crown piece which had stuck in the œsophagus. This considerable quantity of metal only passed through him daily into the close-stool.*

Of all these facts, the three first prove that it acts as a poison, the last five decide in favour of the harmlessness of this metal. As to the fourth, reported by Olaus Borrichius, it may be easily perceived that it is too incomplete to throw any light on this discussion. A severe affection, like malignant fever—might it not have terminated fatally without any external application?

107. It appears to me, that metallic mercury acts as a poison whenever it remains sufficiently long in the digestive canal to undergo a considerable degree of division, and to be absorbed. It is well known, that moisture and grease are capable of attenuating exceedingly the molecules of this metal, to such a degree that they become black.†

There is, then, no doubt, that in the first three cases reported, the mercury retained in the body was divided by the juices of the stomach, and by the grease with which it was mixed in the mercurial girdle. In this state of division it was absorbed, and its poisonous action developed with more or less energy. This opinion acquires additional weight by the following considerations.

1st. We have just now reported a case of poisoning by mercurial vapours; which are nothing more than mercury extremely divided by caloric. 2nd. The mercurial ointment employed in the way of friction in the treatment of the venereal disease, produces often swelling of the gums, pains within the throat, ulcers of the mouth, salivation, vertigoes, fever, trembling of the limbs, and violent pains in the joints. Now this ointment is nothing more, according to the precise experiments of M. Vogel, than metallic mercury mixed with grease, the

* Mémoires de la Faculté Médicale d'Emulation, 4th year, p. 252.

† Journal de Physique, tom. lxx. Mémoire de Vogel.

division of which has been carried to such a pitch, as that the mixture becomes of a blackish colour.* 3d. Swediaur relates, that he has rubbed a dog on the back, without shaving him, with the gray mercurial ointment, and only once in the four and twenty hours. In three days' time his mouth began to be affected; and though the frictions were from that time discontinued, the salivation became very severe: the animal was sick for at least a fortnight, in such a manner, that great fear was entertained for his life. The salivation continued the whole of this time, accompanied with a horrible stench that infected the whole house. 4th. Fabricius de Hilden relates, that a woman being near her husband, who was rubbing in mercurial ointment over a stove, having respired this mercurial atmosphere, experienced such a salivation that her throat was covered with ulcers.† 5th. A surgeon rubbing a patient with mercurial ointment was attacked, according to the report of Frambecarius, with a continued *vertigo tenebrosa.*‡

ARTICLE II.

SPECIES II.—ARSENICAL POISONS.

Var. 1st. Arsenious Acid, or white oxyde of arsenic.
—— 2nd. *Arsenites*, or combinations of that acid with salifiable bases.
—— 3d. Arsenic Acid.
—— 4th. *Arseniates*, or combinations of *arsenic acid* with the bases.
—— 5th. Yellow sulphuret of arsenic.
—— 6th. Red sulphuret of arsenic.
—— 7th. Black oxyde of arsenic, *fly powder.*
—— 8th. Arsenical vapours.

* Annales de Chymie, tom. lxiv. p. 220. Mém. de Vogel.

† Fabricii Hildani Opera, Observationum et Curationum Medico-Chirurgicarum. Cent. 5. Observat. xcviii. p. 435. Francofurti ad Mænum, 1646.

‡ L. ii. cons. iii. cap. viii. Etmuller de Vertigine.

108. The preparations of arsenic are, of all the poisonous substances in the mineral kingdom, the most destructive; and are those, the properties of which the physician ought to be best acquainted with. Being of considerable use in the arts, disposed of in commerce for the purpose of destroying noxious animals, administered and applied every day under various forms for the cure of several diseases, frequently the instrument of crime and suicide, it is not to be wondered at, that they should furnish, more frequently than any others, the opportunity of exercising the ingenuity of professional men.

Fortunately the history of these has been brought by several learned men to a greater degree of precision than that of any other poison. Experiments, beyond the reach of all criticism, have fixed our ideas with respect to the antidotes of the arsenious acid, a deleterious substance which it most concerns us to be acquainted with. Many excellent medical observations have thrown great light on the nature and order of the symptoms resulting from its action: lastly, many ingenious chemical proceedings, proposed at different periods for discovering the atoms of this substance, have greatly enriched this department of medical jurisprudence. We propose laying down here whatever has been ascertained of importance on this subject, adding, at the same time, many chemical facts neglected by authors, and which will serve to complete whatever is necessary to be known with respect to this kind of poisoning.

The order in which we intend to present these facts will be precisely the same as that adopted in treating of mercurial poisons. We shall begin by describing the principal chemical properties of metallic arsenic, the knowledge of which, it appears to us, ought to serve as the basis of all that we have to say on this article.

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OF ARSENIC.

109. Arsenic is a solid metal, of a gray colour like steel, and brilliant when first prepared. Its texture is grained and sometimes scaly, its hardness not very considerable, and its brittleness very great. According to Bergman, its specific gravity is as 8,308.

110. Exposed to the action of caloric in closed vessels, arsenic sublimes and crystallizes in *tetraedral* figures, without melting or experiencing any alteration.

At the ordinary temperature, arsenic exposed to the atmosphere for some time, loses its brilliancy, becomes tarnished, grows black, and is converted into a black oxyde of arsenic at minimum. This fact proves that arsenic is capable of combining easily with oxygen.

If it be heated in contact with the air, it then diffuses white vapours extremely dangerous to respire, and of a smell similar to that of garlick or phosphorus. These vapours when collected, are nothing else than the white oxyde of arsenic at maximum *(arsenious acid)*, formed at the expense of the oxygen of the atmosphere, decomposed by the metal. We shall presently explain a third combination of this metal with oxygen, in which the latter principle is very abundant, and which is known by the name of *arsenic acid.*

111. Arsenic is capable of combining with sulphur, and forms two different sulphurets; one yellow, known by the name of *orpiment;* the other of a reddish colour, called *realgar.* This last contains more sulphur than the other.

112. Being heated with a small quantity of nitric acid, the metallic arsenic is converted into a white substance, which is nothing else than the white oxyde of arsenic *(arsenious acid, deut-oxyde).* If a greater quantity of nitric acid be employed, and these two substances are left to act on each other for a

longer time, a white body will still be obtained, which is the *arsenic acid.* In both cases, reddish vapours are disengaged.

Rationale.—Nitric acid is formed of a great proportion of oxygen, and a certain quantity of azote; the affinity of these two bodies towards each other is very weak, especially at an elevated temperature. Consequently the arsenic decomposes the acid, seizing a portion of its oxygen; whilst at the same time the azote, retaining still a portion of this principle, is disengaged in the state of *nitrous gas,* capable of being converted into red nitrous acid gas, by means of the oxygen of the air contained in the vessel in which the experiment was made.

113. If a certain quantity of metallic arsenic, divided, washed, and perfectly brilliant, be put into a solution of sulphate of ammoniacal copper diluted with water, it will be seen in the space of a few minutes, that the transparency of the fluid is diminished, that its blue colour is bordering upon green; and at length as the turbidness increases, a beautiful green precipitate is obtained, which is *arsenite of copper.* The formation of this precipitate is greatly accelerated by agitation.

Rationale.—The arsenic imbibes a sufficiency of oxygen from the air contained in the water, to pass into the state of arsenious acid; this lays hold of the ammonia, and forms an *arsenite of ammonia* which is soluble: but this arsenite, by virtue of the law explained in the note on § 21, decomposes the sulphate of copper, and gives birth to green arsenite of copper which is insoluble, and to sulphate of ammonia, which is soluble.

This character will be of very great utility to us in the end, in distinguishing the atoms of arsenic in the midst of the animal cinder,* the brilliancy and colour of which greatly resemble the atoms of this metal.

114. Arsenic does not appear to be a poison. Bayen has

* Charbon Animal.

given to dogs as much as a drachm of this metal recently prepared, without producing any perceptible alteration in their health. M. Renault has given to these animals two drachms of *mispickel* (an alloy formed of arsenic and iron): they never experienced either nausea or vomitings, nor has there been any derangement in their functions. This fact appears to confirm the results of Bayen's experiment, but it is not sufficient to prove the innoxious quality of metallic arsenic; for in many experiments it has happened, that the administration of this substance has caused the death of the animals to whom it was given. This effect probably depends upon the facility with which it is converted into an oxyde.

CHEMICAL HISTORY OF ARSENIOUS ACID.

115. The arsenious acid, known under the name of *arsenic*, and *white oxyde of arsenic*, is generally found in the form of white masses, opaque on their exterior surface, yellow, transparent, and as it were vitrified within; its taste is acrid and corrosive; when reduced to powder, it bears some resemblance to sugar pulverized. Its specific gravity is as 5,000.

116. When exposed on burning coals, it volatilizes, diffusing white vapours, very dense, and of a smell resembling garlick. The same thing takes place if it is dropped upon a plate of copper or iron previously heated to redness. A plate of copper placed above these vapours becomes covered with a coat of a *very beautiful white*, and not of a blackish white, as has been improperly pointed out. This coat is nothing else than the arsenious acid, (deut-oxyde of arsenic,) volatilized and attached to the plate: it can be easily scratched off with the finger; upon which the copper regains its natural colour.

117. The arsenious acid dissolves in water. Until lately it has been always thought that it required eighty parts of cold water to dissolve one part of this acid, whereas only fifteen parts

of boiling water are sufficient. M. Klaproth has lately published a series of experiments on this subject; and he proves how widely the chemists were mistaken on the degree of solubility of arsenious acid. According to him, ten ounces of water at the temperature of 12° R. at the end of twenty-four hours, had not dissolved more than twelve grains of this acid perfectly levigated; or, what is the same thing, 1,000 parts of water at the same temperature was only capable of dissolving two parts and a half. If 1,000 parts of boiling water be employed, they are then capable of dissolving 77 parts and a quarter. Lastly, if a quantity of arsenious acid be boiled in water, and the solution be allowed to cool, the superfluous arsenious acid is deposed in the form of tetraedral prisms, and the solution will contain 30 parts of the acid to 1,000 of water.* This solution is without smell or colour, and produces scarcely any effect upon the tinctures and papers of *tournesol* and of *curcuma*: it turns the syrup of violets green, and restores the colour to *tournesol* paper which has been reddened by an acid. Its taste is acrid.

118. Mixed with potash, soda, and liquid ammonia, it forms soluble combinations, called *arsenites*.

119. Lime-water, brought in contact with this solution, produces a precipitate of arsenite of lime. This salt is never black, as is asserted by writers on medical jurisprudence; on the contrary, it is of a very beautiful white. It easily dissolves in an excess of arsenious acid.

120. Sulphurated hydrogen gas, and hydro-sulphurated water, throw down the arsenious acid in a golden yellow precipitate. This precipitate is composed of sulphur and metallic arsenic. It is easy to perceive that the oxygen of the arsenious acid acts upon the hydrogen, to form water; whilst, at the same time, the sulphur and arsenic unite to give rise to a

* Die Aufloslichkeit des weissen Arseniks in Wasser, quantitativ bestimmt Von Klaproth. (*Journal de Schweigger*, vol. vi. cahier 3.)

sulphuret. By this means, the arsenious acid can be discovered in a solution which contains only $\frac{1}{100000}$ part of it.

This sulphuret dried upon the filter, and heated with caustic potash in a small glass tube, (*fig.* 2), becomes decomposed in the course of a few seconds, yields to the potash the sulphur it contains, and thus transforms itself into a fixed sulphuret of potash, and metallic arsenic, which becomes volatilized, and adheres to the sides of the tube. The sulphuret of potash may be easily recognized by dropping into it a drop or two of water; it will exhale a smell like rotten eggs, or sulphurated hydrogen gas. If it be treated by weak muriatic acid, a soluble muriate of potash is obtained, together with sulphur of a yellowish white colour which renders the solution turbid, and sulphurated hydrogen gas, which is set at liberty.

The hydro-sulphurets do not in any manner disturb the solution of arsenious acid, at least, unless a few drops of nitric or muriatic acid, &c. be added to the mixture. In this case the same golden yellow precipitate will be obtained, composed of sulphuret of arsenic.

Rationale. The acid added seizes on the base of the hydro-sulphuret, and sets the sulphurated hydrogen free. The arsenious acid then acts upon this sulphurated hydrogen, which it was not capable of dislodging from the hydro-sulphuret, on account of its little affinity for the bases.

121. The sulphuret of potash dissolved (hydrogenated sulphuret of potash, *liver of sulphur*), put in small quantity into the solution of arsenious acid, gives a white precipitate. If the quantity of the sulphuret employed be considerable, the precipitate becomes yellowish, but never acquires the beautiful gold colour of the sulphuret we have just been describing. It consequently appears to us preferable to employ the sulphurated hydrogen, or the hydro-sulphurets, in order to discover the atoms of arsenious acid.

122. Nitrate of silver is immediately precipitated by the solution of arsenious acid: the precipitate, which is of a

yellow colour, grows black on exposure to the light. It consists of arsenious acid and oxyde of silver. The production of this precipitate takes place even when the solutions are greatly diluted. The lunar caustic, or nitrate of silver cast, being left for a few seconds in a solution of arsenious acid, is equally decomposed, and precipitates yellow flakes formed by the same arsenite.

Rationale. The arsenious acid seizes on the oxyde of silver, with which it is capable of forming an insoluble body. The nitric acid set at liberty remains in the solution. This effect depends, both on the affinity of the arsenious acid for the oxyde of silver, and on the strength of cohesion of the precipitate which takes place.

123. Sulphate of copper dissolved, and brought into contact with the arsenious acid, gives in a few seconds, a flaky green precipitate, which quickly collects together, and which is composed of arsenious acid and oxyde of copper. If the smallest drop of liquid potash be added to the mixture of sulphate of copper and arsenious acid, the green precipitate instantly appears. In this case there is the affinity of the potash for the sulphuric acid, which contributes to facilitate the separation of the oxyde of copper by the arsenious acid.

In order to insure success in forming this precipitate, a grain of arsenious acid may be boiled with three grains of potash; by this means the arsenite of potash is obtained, which, being mixed with five grains of sulphate of copper dissolved in a small quantity of water, gives a beautiful precipitate of a grass-green colour.

This green arsenite of copper carefully washed, on being added to an excess of hydro-sulphurated water, changes colour, is decomposed, and becomes of a brownish red. This effect results from the mixture of the two sulphurets of arsenic and of copper, the former of which is yellow, and the other blackish. The prussiate of potash changes it to a blood red, more inclining to vermillion than the prussiate of copper

alone. The nitrate of silver causes it to pass into the state of yellow arsenite of silver, and a soluble nitrate of copper is formed, of a blue colour. Lastly, if it be dried upon the filter, and sprinkled on burning coals, it diffuses a smell of garlick.

All these characters prove that this precipitate contains arsenious acid; for the oxyde of copper alone acts in a very different manner with the tests we have been describing, as we shall make appear when we come to the article *Copper*.

124. The sulphate of ammoniacal copper (a mixture of sulphate of copper and an excess of ammonia) likewise gives a green precipitate with the solution of arsenious acid. This test, of all those furnished by copper, ought to claim the preference, on account of its extreme sensibility. By its means, this acid can be detected in a solution which contains only $\frac{1}{110000}$ part of its weight of it. It must, however, be observed, that if this sulphate of ammoniacal copper be very much concentrated, the precipitation will not take place.

125. The solutions of crystallized acetate of copper and of verdigrise are instantly precipitated by the solution of arsenious acid: the precipitate is still formed of arsenite of copper of a green colour, more or less inclining to yellow.

126. Prussiate of potash exerts no action on this solution.

127. If the arsenious acid be poured upon the *red mineral cameleon*, (potash and oxyde of manganese melted together,) the red colour of this solution will be seen to change instantly to yellow. This change of colour even takes place when the solution contains only a very minute quantity of the arsenious acid. Scheele and Fourcroy had a glimpse of this fact; but Mr. Fischer, in a memoir given in 1812, has entered much more deeply into it; and he observes, that when atoms of arsenious acid are the object of investigation, the cameleon made use of should be of a red colour, which it does not acquire till it has passed through all the other shades.

Rationale. The red cameleon contains oxyde of manganese

very highly oxydized. It appears, that in this case the arsenious acid lays hold of a portion of the oxygen in this oxyde, and passes into the state of arsenic acid.

The atmospheric air, sulphureous acid, and the alkalies, equally destroy the red colour of this solution; but, as M. Fischer observes, the first acts very slowly, the second renders it colourless, and the alkalies give it a green colour.*

128. Albumine, gelatine, the sugar of milk, *Picromel*, and the resin of bile, do not in any manner disturb the solution of arsenious acid.

129. The arsenious acid in a liquid state, is decomposed by the electric fluid obtained by the voltaic pile. This may be ascertained by the following method: Take a glass tube open at each end, stop up one of its extremities by a piece of bladder, and introduce into it a certain quantity of arsenious acid in a fluid state. This tube must be placed in a vessel containing water slightly acidulated, and into which must be brought the positive conductor of the pile; the extremity of the negative wire being terminated by some coloured metal, such as gold or copper, should be plunged into the solution of arsenious acid. At the end of twelve, fifteen, or four and twenty hours, it will be seen that the extremity of the negative wire is coated with a white metallic crust, which is nothing else but metallic arsenic. Sometimes this effect does not take place before the expiration of several days. A pile of fifty pair of plates of an inch diameter, revives a solution containing only $\frac{1}{60}$ or $\frac{1}{40}$ of solid arsenious acid. It often happens when the quantity of arsenious acid is extremely small, that it is impossible to perceive the revived metal: in this case, by heating the negative wire after the operation, the smell of garlick, which characterizes arsenic, is perceived.

M. Fischer, from whom we have borrowed this fact, ob-

* Journal de Schweigger, vol. vi. cahier i. p. 87.

serves, that Jæger had before proposed this method of reviving the arsenious acid; but that he did not always succeed in obtaining the metal, probably because he brought both the conducting wires into the tube which contained the arsenious acid.

130. Arsenious acid in fine powder, heated with pure white muriatic acid, is completely dissolved after an ebullition of eight or ten minutes. This solution, which is limpid and of a yellow colour, deposits, on cooling, a great quantity of white arsenious acid in a state of powder; being filtered after it has ceased to deposit any sediment, it precipitates strongly on the addition of water: this precipitate dissolves easily in an excess of this fluid. The prussiate of potash precipitates it differently, as the solution happens to be agitated, or left in a state of rest: in the first case, the precipitate is of a sky-blue: in the second, it is white, mixed with some points of sky-blue, and others of a faint rose colour. This precipitate is always soluble in water, and is never of a yellow and green mixed, as is pointed out in works on medical jurisprudence.

131. Arsenious acid in fine powder, mixed with its own bulk of charcoal and potash, is easily revived by heat, and gives out metallic arsenic.

Experiment. Let this mixture be introduced into a glass tube, and all the portion adhering to the sides of the tube be carefully brushed off by means of a feather, so that the superior part of the instrument be perfectly clean and dry: it should then be drawn towards the lamp by its open extremity, in such a manner, that it may present only a very small opening, and thus gradually heated. In the course of four or five minutes, the metallic arsenic becomes volatilized, and adheres to the sides of the tube, at two or three inches from its bottom.

Rationale. The potash seizes on the arsenious acid, and forms arsenite of potash, which is fixed. The charcoal decomposes this arsenite by seizing the oxygen contained in the

arsenious acid, with which it forms a volatile carbonic acid, and the metallic arsenic sublimes. In this conjuncture the use of the potash or of some alkali, becomes indispensably necessary to retain the arsenious acid, which would be volatilized long before the temperature was sufficiently high for the charcoal to carry off its oxygen.

Instead of using charcoal and potash, the black flux might be employed, into the composition of which enters charcoal in a state of extreme division and sub-carbonate of potash, which is obtained by burning in a ladle by projection, two parts of tartar with one of nitre (nitrate of potash).

This method of decomposing the arsenious acid, is preferable to that in which this body is mixed with soap, tallow, &c. because these vegetable or animal substances in undergoing decomposition, give out productions which soil the interior of the tube, and by that means render it more difficult to ascertain with certainty the results.

Bostock proposes another method for the revivification of the arsenious acid: he simply mixes it with its own bulk of charcoal pounded, and a little oil, and puts it into a tube of a quarter of an inch in diameter, and eight inches in length. This tube is coated with a lute composed of one part of common pipe-clay, and three parts of fine sand, and is stopped with clay. He exposes the whole to a red heat: the metal is found incrusted equally over the sides of the tube. Of these two proceedings, the first merits the preference, as it is extremely easy to accomplish.

By either of these methods, the metallic incrustation may be discovered, by only employing $\frac{1}{8}$ of a grain of arsenious acid.*

132. If a mixture be made of equal parts of arsenious acid in solution, and a strong decoction of tea, no disturbance or change of colour will be observed. The solution of nitrate of silver gives with this mixture a yellowish white precipitate, which immediately after becomes black. Lime-water gives a

* Bibliothèque Britannique, année 1809, June.

canary yellow, rather dirty. The sulphate of ammoniacal copper occasions no disturbance, but causes the solution to change to a reddish violet. Lastly, sulphurated hydrogen throws down a sulphuret of arsenic, of a beautiful yellow colour. From these experiments it may be concluded, that of all the re-agents we have pointed out, the last is the only one that can create any suspicion of the presence of arsenious acid which might be mixed with tea.

133. A decoction of coffee, poured into an equal bulk of a solution of arsenious acid, produces no disturbance. The fluid resulting from this mixture, gives a deep yellow precipitate with the nitrate of silver: one nearly green with the sulphate of ammoniacal copper: a golden yellow with the sulphurated hydrogen; and lastly, a yellow one with lime-water: the colour of this last precipitate makes it appear, that lime-water is of no value in detecting the presence of arsenious acid combined with a decoction of coffee, since that alkali throws down the arsenious acid in a white precipitate. The green precipitate, obtained by the sulphate of ammoniacal copper, proves that this test may be employed with success, when the arsenious acid is united with coffee.

134. If a mixture is formed of ten parts of wine and one part of arsenious acid in solution, the liquid preserves its transparency, and gives a deep yellow precipitate with the sulphurated hydrogen; a dark blue with the sulphate of ammoniacal copper; and white with the nitrate of silver. A mixture composed of ten parts of wine, and seven of arsenious acid, gives a golden yellow precipitate with the sulphurated hydrogen; a green with the sulphate of ammoniacal copper; and a white one with the nitrate of silver. The precipitation by this last test, does not take place till after the expiration of some time, at least, unless a much greater quantity of the arsenious acid be employed, than is here specified. It follows from these experiments, that the presence of the arsenious acid cannot be detected by the sulphate of ammoniacal copper, whilst it is

united to a very considerable quantity of wine; and that the nitrate of silver is of no use as a test, even when the arsenious acid shall be found mixed with a very small quantity of this spirituous liquor.

135. The arsenious acid does not disturb the solution of albumine: the fluid resulting from a mixture of these two bodies gives a white precipitate with the nitrate of silver, and with the other tests furnishes the same precipitates as are obtained from the arsenious acid alone.

136. The same thing occurs with gelatine.

137. A mixture formed of equal parts of broth and of arsenious acid in solution, undergoes no sensible change. The nitrate of silver produces a white precipitate, and the sulphate of ammoniacal copper, changes its colour to a dirty green, without throwing down any sediment. Lime-water, and sulphurated hydrogen furnish the same precipitates as with the pure arsenious acid.

138. If the arsenious acid be mixed with human bile, no disturbance is perceived, and the four tests of which we have spoken, precipitate the fluid in the same manner as if no bile was contained in it.

139. If one part of arsenious acid in solution be added to ten parts of milk, sulphurated hydrogen will change the white colour of the fluid to a canary yellow; the sulphate of ammoniacal copper imparts to it a tinge slightly green; and the nitrate of silver does not occasion any visible change on the addition of a greater quantity of arsenious acid: the hydrosulphurets give a precipitate of a golden yellow colour, provided one or two drops of acid are added (§ 120.); the sulphate of ammoniacal copper will give a green precipitate, and nitrate of silver a white one, whatever may be the quantity of arsenious acid employed.

140. The fluid contained in the stomach of a rabbit that had been poisoned with a solution of three grains of arsenious acid, furnished a white precipitate with the nitrate of silver;

a grayish white with lime-water; green with the sulphate of ammoniacal copper; and a deep yellow with hydro-sulphurated water.

141. I evaporated separately, mixtures of arsenious acid with wine, tea, coffee, broth, albumine, gelatine, and milk; I obtained productions, which, when treated with boiling distilled water, have constantly furnished a fluid in which the presence of the arsenious acid might be demonstrated, by one or other of the four following re-agents: the sulphate of ammoniacal copper, sulphurated hydrogen, nitrate of silver, and lime-water. Some of these tests furnished a precipitate different in colour to what the arsenious acid would have furnished without mixture. The sulphurated hydrogen has almost always given a yellow precipitate: the sulphate of ammoniacal copper, less constant in its mode of action, has not always furnished a green one: the lime-water and the nitrate of silver, have often presented depositions of a different colour to those which they form with the arsenious acid unmixed.*

142. All these mixtures, when evaporated to dryness, and calcined with potash and charcoal in a tube, (*fig.* 3) yielded metallic arsenic, shining, volatile, and adhering to the sides of the tube.

ACTION OF ARSENIOUS ACID UPON THE ANIMAL ECONOMY.

143. This acid, whether administered internally, or applied externally, acts with a great degree of energy, and destroys life usually in a very short space of time. What is the kind of

* It may readily be conceived, that the nitrate of silver, lately proposed by Mr. Home for discovering the arsenious acid, ought to be a very uncertain test in a great number of cases. In fact, if the quantity of arsenious acid mixed with the food be very small, and these contain muriates; there ought to be formed at the same time, a small quantity of arsenite of silver of a yellow colour, and a great deal of muriate of silver of a white; in such manner that the precipitate would appear of this last colour, whilst it ought properly to be yellow.

action produced by this substance, and in what manner does death happen from it?—Mr. Brodie has published a work, the intention of which is to resolve these two questions. We shall give an account of the conclusions at which he arrived.*

The most generally received opinion is, that the arsenious acid being brought into contact with the stomach, produces a local inflammation, which ought to be considered as the cause of death. The English physiologist rejects, with reason, this explanation, in order to make way for another, which appears to us better founded. He asserts, that the arsenious acid, whether administered internally, or applied externally, begins by entering into the circulation; that it exerts its action upon the nervous system, the organs of the circulation, and the alimentary canal; and that death is the immediate result of the suspension of the functions of the heart and brain. The following are the experiments which have induced Mr. Brodie to adopt this opinion.

Experiment 1st.—He applied seven grains of arsenious acid upon a wound made on the back of a rabbit. A few minutes afterwards, the animal was languishing, its breathing short and accelerated, the pulse feeble and imperceptible, the posterior extremities paralyzed; it became insensible and motionless, except that from time to time it had convulsive twitches; it died fifty-three minutes after the application of the arsenious acid. On opening it, the heart was found still contracting, but very feebly and slowly: its action could not be prolonged by the inflation of a portion of air into the lungs. The internal coat of the stomach was slightly inflamed.

Experiment 2nd. Two drachms of arsenious acid dissolved in six ounces of water, were injected into the stomach of a dog. Three minutes after, he vomited a certain quantity of mucus: these vomitings were repeated several times; the pulse became less frequent, and somewhat intermitting. Thirty-two

* Philosophical Transactions, year 1812.

minutes after, the posterior extremities were paralyzed; the sensibility was greatly diminished, and continued growing less and less. Forty-five minutes after the ingestion of the poison, the pupils were dilated; the pulse was fallen from a hundred and forty pulsations, to seventy in the minute; the intermissions were frequent. He became almost insensible; convulsions came on, and he died five minutes afterwards. On opening the thorax immediately after death, a slight trembling of the heart was observed, but by no means sufficient to maintain the circulation; the stomach and intestines contained a great quantity of mucus, and their internal coat was strongly inflamed.

These experiments being repeated, were followed by the same results.* According to this author, the various symptoms observed in animals submitted to the action of this acid may be reduced to the three principal which follow. 1st. Those depending on the nervous system, such as paralysis, first of the lower extremities, and afterwards of all the other parts of the body; convulsions, dilatation of the pupils, and general insensibility. 2nd. Those which indicate a derangement in the organs of the circulation; for example, the pulse weak, slow, and intermitting; weakness of the contractions of the heart after death, and the impossibility of prolonging them by the assistance of artificial respiration. 3rd. Lastly, those which belong to the lesion of the alimentary canal, such as pains in the abdomen, nausea, and vomitings in such animals as are capable of vomiting.

* Sprægel had before observed, that after having sprinkled with a drachm of arsenious acid a wound which he had just made on a dog's back, there appeared convulsions and signs of extreme pain; and that death took place at the end of five hours. The stomach and intestines were greatly inflamed, both on their exterior and interior surface: coagulated blood was effused into their cavities, and had insinuated itself between their coats. The wound was livid and tumefied. The pleura, pericardium, and lungs, appeared very red and inflamed.—*Sprægel Experimenta circa varia Venena, Disp. Med. Goettingue*, 1753, in 4to.

Sometimes it is the nervous system which is most seriously affected; at others, the organs of the circulation. In the case of the dog which is the subject of the second experiment, it is observed that the heart did not contract any more after death; whilst in the rabbit, feeble contractions might be perceived. The nervous symptoms, on the contrary, were more severe in the latter of these animals.

144. According to these details, it appears that inflammation of the stomach and intestines, ought not to be considered as the cause of death, in the greatest number of cases of poisoning by the arsenious acid. Nevertheless, if the animal does not sink under the first symptoms occasioned by the poison, if the inflammation has time to develope itself, there is not the least doubt that it is capable of destroying life. M. Earle relates, that a woman who had taken arsenic, resisted the alarming symptoms which first declared themselves, but died on the fourth day. On opening the body, the mucous membrane of the stomach and intestines was found ulcerated to a very great extent.*

SYMPTOMS OF POISONING BY THE ARSENIOUS ACID.

OBSERVATION I.

M. Tonnelier was called on the ninth Nivose, year 10, at eleven at night, to the house of Madame L***, to give assistance to her daughter, aged nineteen years, who was reported to be in a cruel situation. He found her, in fact, in a state of extreme faintness, kneeling down on the floor of her room, with her head resting on the arms of her brother, being unable any longer to support herself. Her face was unequally red, and covered with sweat; her eyes were half open, red, and suffused with tears; round her eye-lids was a border of a bright red; her voice was nearly gone; her breathing short,

* Philosophical Transactions, Memoir of Mr. Brodie, 1812.

frequent, and plaintive: she experienced horrible pains in the stomach, like those which would have been produced by fire; and she made efforts to vomit, which were extremely distressing. She had been four hours in this situation. The patient, on being interrogated by M. Tonnelier, acknowledged that she had taken arsenic *(arsenious acid)* in the morning. It is thought that she took this poison about eleven o'clock in the morning, in some broth which she had made for her breakfast. Nevertheless, no symptom of a very distressing nature had made its appearance till the evening: during the day she had been observed often to change colour in the face, and shewed some other signs of suffering and anxiety; but she was obliged to conceal her pain, and to appear with a serene countenance. She ate a very good dinner at two o'clock. At seven in the evening the vomitings came on with extreme violence: at eight she had a slight convulsion, which lasted several minutes, after which the vomitings returned with the same violence as before. As she had refused to drink, the matter vomited was reduced to a very little: it was composed of a part of her dinner, of a viscous matter, sometimes colourless, sometimes of a pale yellow; together with some frothy saliva with some streaks of blood. The patient was put to bed, by the advice of M. Tonnelier. Her pulse was small, unequal, irregular, and very frequent. The epigastrium possessed an excessive degree of sensibility, and there were also very excruciating pains in the intestinal canal. Her swallowing was already extremely difficult; nevertheless they succeeded in making her drink copiously. By this means she vomited more easily and without interruption for a whole hour: the vomitings then ceased for about ten minutes. The patient rested herself upon her pillow, and appeared to sleep; she was even heard to snore: but, in a short time, a succussion of the stomach awoke her, and the vomitings were repeated until two o'clock. Her situation became more and more distressing.

At a quarter past two, a second appearance of sleep for

eight minutes; snoring, respiration slower, hiccup, vomitings for a quarter of an hour, coldness of the face, hands, and forearms; she uttered cries from time to time; agitation extreme; contortion of all the limbs; a spontaneous stool, which was the second since the invasion of the symptoms.

At three o'clock a little calm; she begged of the attendants not to speak of her misfortune. Her breathing became still slower, the coldness increased; fresh signs of agitation, frightful dreams; the pulse became insensible. At four o'clock she opened her eyes, and complained that she could not see the light: she lamented her fate: her arms became as if dead. At five o'clock her face was like ice, her nose and lips of a violet colour, the beating of her heart could scarcely be felt; to this succeeded a slight rattling in the throat, and death.

This young person, tormented by disappointment, had already tried twice to destroy herself by poison.

Nine months before, M. Tonnelier being called to her assistance, found her in a situation very similar to that we have just described; but the symptoms had a much less degree of intensity; doubtless, because the dose of poison had been very small. The patient then quickly recovered by the assistance of mucilaginous drinks; there remained only a pain in the lower part of the right side of the stomach, which she constantly afterwards felt. As to the second poisoning, it was still less severe than the first.

Appearances on Dissection.

Externally: contraction of the muscles of the face, insurmountable stiffness of the limbs; a violet colour, more or less deep, over the legs, thighs, loins, and back; countenance pale, lips violet; a very sensible heat of the body twenty-six hours after death.

Internally: the lungs were extraordinarily distended with blood, through two-thirds of their bulk, and especially in their posterior part. The incisions made in them shewed their tex-

ture compact and tolerably firm; from these oozed out, on the slightest pressure, blood, without any appearance of air-bubbles, from a multitude of minute points. The anterior part of the lungs was red on the surface, but in other respects, tolerably elastic, and filled with air.

Both ventricles of the heart contained very black blood. The left ventricle contained more than the other.

The stomach was greatly distended by the fluid with which it was still filled; on its external surface was seen an infinity of small vessels injected with blood. The intestinal canal exhibited the same appearance, as well on its external as internal surface, in some parts of its extent. The liver and spleen were likewise very much distended with blood.

The stomach having been emptied, and laid open throughout its whole extent, presented a surface apparently grained, which appearance was caused by the increased bulk of the mucous glands, the colour of which was blackish, whilst the stomach itself was red, more or less dark, and sprinkled here and there, especially towards the pyloric orifice, with extremely black patches.

The epidermis of the mucous membrane was entirely removed. Near the cardiac orifice was seen a line of demarcation, which, rising higher than in its natural state above the level of the internal surface of the stomach, proved clearly this removal of the epidermis. There was beside no deep erosion. Two days after the opening of the body the red colour had entirely disappeared, and the black was changed into a dark red.

There was found in the fluid taken out of the stomach a cyst, formed, according to Professor Dupuytren, by an expansion of the mucous membrane of the stomach, in which some vestiges of the vessels could still be perceived. It was about an inch and a half long, eight lines in diameter, and its sides were about half a line in thickness. From the interior surface of this cyst, were given out very thin partitions of a

cellular appearance, and which contained, in distinct cells, unequal fragments of a crystalline matter, which, being submitted to several experiments, by M. Dupuytren and M. Vauquelin, presented all the characteristics of *arsenic* (arsenious acid). The learned surgeon, whom we have just quoted, is of opinion, that the production of this cyst belonged to the two poisonings anterior to that which terminated the existence of the patient. This opinion appeared to him to be strongly supported by the circumstance, that the patient complained of continual pains in the part of the stomach corresponding to that where the cyst was found.*

OBSERVATION II.

On the 22nd of April last, a girl named *Menbielle*, about twenty-seven years of age, unfortunately found the means of procuring herself some arsenic; it was given her in a mass, I know not in what dose. She ground it between her teeth a part of the day, and put some small fragments of it into a glass of water, which she swallowed. She happened, however, to be surprised, and what remained at the bottom of the glass discovered her fatal design. After denying a long time that it was arsenic, she was at length convicted by a lump as large as a filbert, which was found in her pocket, and which appeared to have been gnawed.

For several hours this girl persisted in her execrable project, and obstinately refused every assistance offered. She protested that she had taken but very little of the poison. She appeared to be in great distress, and her countenance expressed disappointment and sullenness. It was necessary to employ force to compel her to swallow some water, oil, and milk.

I arrived while this was performing, about six o'clock in the evening. When at length, by force of entreaties, I had obtained from her the fatal secret, and compared the very

* Journal de Médecine, Chirurgie, Pharmacie, par M. M. Corvisart, Leroux, et Boyer, tom. iv. an. 10, p. 15.

small quantity of the poison she confessed to have taken with the slightness of the symptoms with which I saw her affected, I acknowledge that I became the dupe of her false confession, and hoped that the poison, swallowed in small masses, consequently not dissolved, and for that reason attacking fewer points of the villous coat of the stomach, might be more easily evacuated, and would produce on that organ only slight erosions.

I believed my hope of saving this poor girl from a premeditated suicide, to be so much the better founded, because I saw her at length yield to our entreaties to drink abundantly, and beg to speak to her confessor. She affected an air of confidence and tranquillity, and asked only to be allowed repose, assuring us that she absolutely suffered no pain. In fact, having examined her very attentively, I found her cool, her pulse tranquil, and not tight; her mouth in its natural state, without the least excoriation, swelling, or ptyalism; there was no spasm about the throat or jaw, no swelling of the stomach or abdomen, no nausea. She had had no vomiting before our interference; but she had a great deal afterwards, which was accomplished with the greatest ease. Each vomiting was followed by some of the poison, part of which was half dissolved, part in small fragments, still hard, and of the size of millet seeds.

In consequence of the quantity of poison brought to light by the vomitings, I began to suspect the patient's confession. She appeared to me not, till eight o'clock, to feel pain in the stomach: it seemed that our presence and our attentions were very troublesome to her; and she constantly solicited our departure. She several times asked for her pockets. I had them examined, and found in them a great quantity of arsenic in small lumps, mixed with dry crumbs of bread. I ordered a drachm of salt of wormwood to be given her in a glass of milk and water of marsh-mallows; and caused the same dose to be dissolved and kept in two or three other glasses. The

patient had taken the whole at ten o'clock; she had vomited a great deal, and always threw up some arsenical substance. I had taken care, the same evening, to have several fat glysters administered.

Towards eleven, she affected a greater tranquillity than ever; she turned upon her side, and expressed to me the greatest inclination to sleep. She continued all along in the same state of apparent tranquillity that I have described at the first quarter of an hour of my visit. Several glysters were administered to her, and she continued to drink whey till three o'clock in the morning, when she sat up in the bed, complained a little of the stomach, and expired without the least agony.

The body was opened the next day. On exposing it, we found a number of livid spots, especially about the mouth, neck, clavicles, and the right breast. The lower part of the false ribs likewise presented several small ecchymoses.

On opening the œsophagus and stomach, we found a considerable distension and varicose dilatation of the vessels of these parts. The cavity of the stomach contained several ounces of a brown fluid, which appeared to us to be only the residue of the drinks taken the evening before. We found, beside, a fold or rumpling at the cardia, filled with a large clot of blood, and with some mucosity containing several fragments of arsenic, white, half dissolved, and of the size of a millet seed, such as we had seen the patient vomit. The intestinal canal was empty; its vessels were very much distended with blood. We found there likewise, though less abundantly than in the stomach, small fragments of arsenic, still hard; but which, by dissolving in the alimentary canal, have likewise, by their causticity, been the cause of the sudden death of the patient. The other viscera presented nothing particular to our inquiries.

Agreeable to the *procès verbal* of this dissection, it is certain that the girl *Menbielle* died *poisoned* by *arsenic*. But, when we compare the symptoms with the fatal event, what kind of destruction did nature here experience? There were no violent

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vomitings, no signs of severe pain, no convulsions, very little thirst, no dryness of the mouth. Death has, nevertheless, quickly followed.*

OBSERVATION III.

M. J. B. Desgranges relates the following case.

On the 5th Thermidor, year 4, on my return from Lyons, I was sent for in a hurry to see a young woman, who was a chamber-maid near Rolle; and who had been so imprudent as to rub her head, six or seven days preceding, with an ointment containing a portion of arsenic, for the purpose of destroying vermin. Her head was perfectly sound without the least scratch. For which reason several days elapsed before she had any reason to complain of this fatal application. But at length, without doubt from the effect of absorption, either by the natural pores of the hairy scalp, or by means of some erosion made by the caustic action of the mixture, the patient was attacked with the most cruel pains. The whole head was become swelled; the ears, which were twice their natural size, became covered with scabs; several sores on the head were in the same state, and the submaxillary and jugular glands, those of the neck, of the back of the head, and the parotids even, were rapidly distended. The eyes were sparkling and large; the face was tumefied and almost erysipelatous. The patient's pulse was hard, tense, and febrile; the tongue parched, the skin dry. She complained of a pungent heat over the whole body, and of a fire, which she described as devouring her. To these external evils were joined vertigoes, faintings, cardialgia, vomitings from time to time, thirst, heat of urine, obstinate constipation, trembling of the limbs, with an impossibility of supporting herself on her legs. Her head was wandering, and there were moments of delirium.

* Case reported by M. Laborde, Physician.—*Journal de Médecine*, tom. lxx. p. 89, 1787.

I took away immediately, (at seven in the evening), a large quantity of blood from the patient, and recommended a bleeding from the foot during the night. I prescribed for her a copious dilution, with chicken broth made into an emulsion with the addition of nitre, frequent glysters of linseed and other herbs; bathing the feet in warm water in which wood-ashes had been boiled; and, seeing the necessity of relaxing the belly by gentle means, I gave the preference to a mixture with calcined magnesia, gum arabic, and syrup of coltsfoot, of which a tea-spoonful was given every two or three hours. I ordered the head to be anointed with the *cream ointment* described in the Pharmacopeia of Baumé, containing a quarter of its weight of white chalk in powder. The next day there was some little amendment, but a great degree of drowsiness. I then ordered eight or ten leeches to be applied to the thighs; notwithstanding which the night was passed in a state of agitation, the swelling of the head appeared to be increased, and about morning the whole body was covered with a considerable eruption of small pimples, with white heads like millet, especially the hands and feet. The patient was extremely weak, and could not sit up without feeling nausea. I administered a few spoonfuls of a draught rendered cordial by the addition of some drops of Hoffman's æther, and several glasses of an infusion of burdock with honey. The day after I repeated oftener the doses of calcined magnesia, mixed only with the syrup of coltsfoot, in order to determine more decidedly evacuations by the bowels. In less than forty-eight hours the eruption dried up and desquamated, the bowels were opened, all the symptoms diminished; and on the eighth day from my first visit, the patient was entirely out of danger. As there remained some irritation and dryness about the chest, with a little cough, I finished the cure by asses' milk. In the course of her convalescence the hair fell off.*

* Recueil Périodique de la Société de Médecine de Paris, tom. vi. p. 22.

OBSERVATION IV. *By M. Roux.**

I had amputated the breast of a girl eighteen years of age, endued with an excess of the lymphatic temperament, and in whom a scirrhus of considerable magnitude in this organ had not yet altered the bloom of youth. The wound had advanced rapidly towards healing, and the cicatrix had been several days completed, when an ulceration, accompanied with slight darting pains, made its appearance spontaneously in the centre. The fear I was under of causing too great a fright in this young girl, made me renounce the intention I first had of employing the actual cautery; I consequently decided on the employment of the *pâte arsenicale*, which was accordingly applied over a surface of about an inch, or at most an inch and a half, in diameter.† The day after, the patient began to complain of violent colics; she experienced some vomitings, and her countenance began to alter. Two days afterwards, she died in violent convulsions and dreadful agonies. The body, which was sprinkled over with large ecchymoses, quickly putrefied. On opening it, we found the internal surface of the stomach, and of a great part of the intestinal canal, in a state of inflammation, and sprinkled over with black spots. I am convinced that this girl died poisoned by arsenic.‡

The symptoms produced by arsenious acid, generally considered, may be reduced to the following:

* Nouveaux Elémens de Médecine operat. par I. P. Roux, tom. i. p. 64. 1re. edition.

† The arsenious acid forms the basis of this *Pâte*.

‡ We could report a much greater number of cases of poisoning by this acid; but shall content ourselves with pointing out a part of the works in which they may be found:

De Haen Ratio Medendi, tom. v. part ix. cap. vi. § 6, p. 324.

J. B. Morgagni Epist. Anat. Med. 59, art. iii. p. 244. (De Sedibus et Causis Morborum.)

Fabric. de Hilden, oper. citat. Obs. lxxx. p. 606, and Obs. lxxxi. p. 607. Francofurti ad Mœnium, 1646.

An austere taste, fetid mouth, frequent ptyalism, continual spitting, constriction of the pharynx and œsophagus, the teeth set on edge, hiccup, nausea, vomiting of a matter sometimes brown, sometimes bloody; anxiety, frequent faintings, heat of the *præcordia*, inflammation of the lips, tongue, palate, throat, and œsophagus; the stomach painful to such a degree as not to be able to support the most emollient drink; the alvine discharges blackish, and of a horrible fœtor; the pulse small, frequent, concentrated, and irregular; sometimes slow and unequal; palpitation of the heart, syncope, unquenchable thirst, pungent heat all over the body, sensation as of a devouring fire; sometimes an icy coldness; breathing difficult; cold sweats; urine scanty, red, and bloody; change of the features of the countenance; a livid circle round the eyelids; swelling and itching over the whole body, which is covered with livid spots, and sometimes with a miliary eruption; prostration of strength; loss of feeling, particularly in the feet and hands; delirium, convulsions, often accompanied with an insupportable priapism, falling off of the hair, detachment of the epidermis; and lastly, death.

It is rare to see all these symptoms united in the same person; sometimes almost all of them are wanting, as is proved by observation 2nd, of which M. Labord is the author, and the following fact reported by M. Chaussier.

A robust middle-aged man swallowed a quantity of arsenious acid in large lumps, and died without discovering any other symptoms than slight syncope. On opening the stomach, it was found to contain the arsenious acid almost in the state in which it had been swallowed.

146. In the second section of this work, when speaking of slow poisoning, we shall assert, that it may happen that the symptoms produced by this poison are not so fatal, whether because the quantity taken be not considerable, or because a portion has been thrown up by vomiting; or lastly, because assistance has been given before its whole effect be produced.

We shall not till then, lay down the method of appreciating properly, the importance of the different symptoms, and the advantage which the juridical physician can draw from them, when called upon to decide.

LESION OF TEXTURE ATTRIBUTED ESPECIALLY TO THE ARSENIOUS ACID.

147. In this kind of poisoning, as well as that by corrosive sublimate, Sallin maintains, that the changes visible in the dead body resulting from the action exercised by the arsenious acid, possess a character proper to themselves; for which reason, when he wishes to establish a difference between sublimate and arsenic, he says, "arsenic produces in truth, effects "very analogous to those of sublimate; there are, however, "very remarkable differences: in that it sometimes perforates, "and renders the stomach gangrenous; in that it exerts its "action upon the whole of this viscus, upon the mouth, and "the whole extent of the œsophagus; and that it excites an "eruption on the skin."*

We cannot admit the assertion of Sallin: when an object of such great interest is discussing, all general propositions require, in order to be admitted, a multitude of facts, often difficult to collect, and which our author appears to be deficient in.

It is certain that there are many cases of poisoning by arsenious acid introduced into the stomach, in which this viscus and the intestines are perfectly sound. In the fact reported by M. Chaussier, it was not possible to discover the slightest appearance of erosion or inflammation in the digestive canal. Etmuller speaks of a young girl poisoned by arsenic, in whom neither the stomach or intestines presented any signs of inflammation, or gangrene; nevertheless, the arsenic was

* Recueil Périodique de la Société de Médecine de Paris. tom. vii. p. 357.

found in this viscus.* M. Marc relates, that in a case of poisoning by the oxyde of arsenic (arsenious acid), far from finding the membranes of the stomach eroded, they were found thickened.† Sallin himself says, " at the opening of a man " who died from poison, and in whose stomach was discovered " a drachm of arsenic in powder, nothing preternatural was " found in the mouth or œsophagus." ‡

148. It may however in general be said, that the mouth, œsophagus, stomach, and intestines, are inflamed; that the stomach and duodenum sometimes present gangrenous spots, sloughs, perforations of their coats; that the villous lining of the stomach is as it were destroyed, and reduced to a paste of a reddish brown colour; lastly, that all the other viscera are more or less inflamed.

I believe these remarks are sufficient to enable the physician to perceive, that the existence or non-existence of lesions in the dead body, the extent and the seat of these alterations are never sufficient to decide, whether poisoning has, or has not taken place, and that they can only serve at most, to corroborate the conclusions drawn from the chemical analysis of the materials.

149. M. Brodie has made a series of interesting observations on the lesions of the stomach of several animals poisoned by the arsenious acid. We shall report them, as they appear to us to throw some light on the subject of which we are treating.

In many cases the inflammation of this viscus is extremely slight. In general, it begins to develope itself immediately after swallowing the poison; and it is by so much the more intense, as death takes place later after the accident: it is less in granivorous, than in carnivorous animals: it never extends

* Ephemerid. Nat. Curios. Cent. iii. and iv. Obs. cxxvi. cum Scholio.

† Marc Traduction de Rose; Manuel d'Autopsie Cadaverique, p. 66, Note.

‡ Journal de Médecine, tom. lviii. p. 176.

to the œsophagus or pharynx: its intensity and the rapidity with which it takes place, are much greater when the arsenious acid is applied to an ulcerated surface, than when it is introduced into the stomach. Messrs. Home and Hunter had already made this remark. The inflamed parts are generally red throughout their whole extent; sometimes the redness is only observed in patches; the principal vessels of the stomach are distended with blood; but the inflammation is usually confined to the mucous membrane of this viscus. This membrane, which is of a vermillion red colour, softens into a kind of pulp, and separates with ease from the muscular coat, which preserves the character proper to its texture. Sometimes small portions of extravasated blood are observed on the surface of the mucous membrane, or in the space between it and the muscular coat. Ulceration, or sloughing of the stomach and intestines, is never found when the animal dies in a short time; but if death is late in taking place, either of these terminations may happen. On this subject, the author observes, anatomists are very often mistaken as to the true nature of these sloughs. On opening the stomach of a dog that had taken a strong dose of arsenious acid, he observed a dark spot about an inch in diameter, having all the appearance of a slough. However, a closer examination proved, that this spot was nothing more than a very thin coat of coagulated blood of a very dark colour, and strongly adhering to the mucous membrane. The stomach of a man poisoned by arsenic, preserved in Hunter's museum, furnished M. Brodie a fresh proof in favour of his opinion; in fact, this anatomical preparation, preserved on purpose to shew a slough produced by this poison, presents simply a coat of coagulated blood, similar to that we have just described.*

* Philosophical Transactions, year 1812, February.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE VARIOUS CASES OF POISONING BY ARSENIOUS ACID.

150. We ought to examine carefully the various proceedings, by the assistance of which, the person has to decide affirmatively, that poisoning by the arsenious acid has taken place. The impossibility of effecting the decomposition of this acid by any alimentary substances, whether vegetable or animal, at the ordinary temperature; the multiplicity of the means furnished by chemistry to distinguish it from other substances; lastly, the facility with which the metallic arsenic can be extracted; are so many conditions which render the solution of this problem much more easy, than that of the poisons which we have hitherto considered. This will be put beyond a doubt by the details which we are now about to enter into.

FIRST CASE.

The Person is living: the Remainder of the Poison can be procured.

151. An attentive examination of the symptoms of the patient, the recapitulation, and the chemical analysis of the poisonous substance, are sufficient to inform the medical investigator in this case, which is by no means difficult.

A. If the substance to be investigated is solid, and in the form of a powder, about half a grain of it should be dissolved in about half an ounce of distilled water, the temperature of which should be raised to 80°. This solution brought in contact with the sulphate of ammoniacal copper, hydro-sulphurated water, the hydro-sulphurets, nitrate of silver, whether in solution or solid, the red solution of the mineral cameleon, water saturated with lime, and syrup of violets, will act in the manner we have pointed out in the foregoing pages, in the chemical history of arsenious acid. Another part of the

powder should be mixed with its bulk of charcoal finely powdered, and potash of commerce (salt of tartar). The mixture being exposed for some minutes to the action of caloric in a glass tube (*fig.* 3), will furnish metallic arsenic extremely brilliant, adhering to the sides of the tube, diffusing vapours of a smell resembling garlick if put upon the fire; and giving a green precipitate with the sulphate of ammoniacal copper (§ 110 and 113). I have often discovered even the eighth of a grain of arsenious acid, by following this very simple process. These characters, which may be easily demonstrated upon a quantity of arsenious acid not exceeding a grain, are sufficient for the person officially employed, to pronounce decidedly on the nature of this body.

It may happen, that the quantity of metallic arsenic obtained, is so small, that it cannot be detached from the tube; it sometimes is no more than a very slight coat of a tarnished gray powder, which covers the sides of this instrument. In this case, having carefully collected all the fragments of glass coated with this dust, a part of them should be put into sulphate of ammoniacal copper, the remainder should be placed on burning charcoal. The phenomena produced by the arsenious acid, will appear in the same manner as if the metallic arsenic was by itself. After making these experiments, in order to obtain a greater degree of certainty, the solution of arsenious acid may be submitted to the action of a current of the galvanic fluid (§ 129); the metallic arsenic will attach itself after a certain time to the negative wire, terminated by gold or copper. This characteristic may very well be dispensed with, by those who may not have a galvanic pile.

If the arsenious acid be in a lump, we should begin by ascertaining whether it possesses the physical properties assigned to it (§ 115); then it should be reduced to powder, to submit it to the experiments we have just pointed out.

B. Suppose a case in which this acid forms part of a plaster, or some other external application: after cutting or dividing in

any manner this preparation, a part of it should be treated with six or seven times its weight of distilled water boiling; the filtered solution should then be brought in contact with the tests we have just enumerated; and it may be decided that it contains arsenious acid, if it acts with them in the manner we have stated; and if metallic arsenic is obtained by calcining the other portion with an equal bulk of pounded charcoal and potash of commerce. The transformation of this plaster or external application into metallic arsenic becomes a test of the utmost necessity, especially where some of the other agents employed, may have furnished precipitates very feebly marked, or that have undergone some change in their colour; a circumstance very likely to occur, when these preparations are composed of several substances, both mineral, vegetable, or animal.

If after half an hour's boiling, the distilled water exhibits no trace of arsenious acid, all the solid pieces should be mixed with charcoal and potash, and calcined, in order to obtain metallic arsenic, which should be brilliant, and possessed of the properties of which we have several times spoken. The presence of the metal thus obtained, removes every doubt as to the nature of the poison.

SECOND CASE.

The Person is living: the whole of the Poison has been swallowed: the Matter vomited may be submitted to Experiment.

152. 1st. If the matter vomited be liquid, a portion of it should be filtered, and submitted to the tests pointed out § 151, A; if these menstrua furnish the precipitates which are ordinarily given by the arsenious acid, the remaining portion should be evaporated to dryness, after having added about half an ounce of potash, and then mixed with charcoal, in order to be calcined in a glass tube, drawn to the lamp by its open extremity (*fig.* 3). If metallic arsenic be obtained, shining

and adhering to the sides of the tube, it may be safely affirmed, that the liquids vomited contained arsenious acid. If the tests employed should act differently to what they would do in a solution of arsenious acid, the matter should then be evaporated, in order to proceed to the reduction, as we have just now explained; for it is not until metallic arsenic cannot be procured, that we can pronounce decidedly, that these fluids do not contain arsenious acid.

2ndly. If the matter vomited be both liquid and solid, the liquid part should be submitted to the action of the tests above enumerated, and the solid portion should be examined, to see if it contain any white, hard particles, similar to the arsenious acid; in which case, they must be carefully separated and analysed. If, however, all attempts to find out the poison prove ineffectual, the solid portion must be divided into two parts, one of which should be treated with twelve or fifteen times its weight of boiling distilled water, and the other calcined with potash and charcoal. The nature of the solution obtained, when submitted to the tests pointed out, and the revivification of the metallic arsenic, will leave no doubt as to the presence of the arsenious acid.

It may happen that the quantity of solid matter vomited is so great as not to allow of the reduction being effected in a small glass tube: in that case a retort of stone should be procured, coated with a lute of clay and sand. The mixture should then be introduced into the retort, with a balloon fitted to it, and heated to redness; the metallic arsenic will sublime into the neck of the retort.

3dly. If the matter vomited be fluid and very abundant, and gives a yellow precipitate with the sulphurated hydrogen; it should be mixed with an excess of hydro-sulphuret of ammonia, and a little muriatic acid: by this means the whole of the arsenious acid will be decomposed, and transformed into a yellow sulphuret: it should then be filtered, and this sulphuret will remain on the filter. This must be dried and cal-

cined with a little potash in a glass tube: it is clear that by the action of heat, the potash will lay hold on the sulphur, with which it is capable of forming a fixed body; whilst the metallic arsenic being volatile, will be set at liberty, and attach itself to the sides of the vessel. This method is preferable to that of evaporation, when a very great quantity of fluid is to be examined.

THIRD CASE.

The Person is living: the whole of the Poison has been swallowed; the Vomitings cannot be examined.

153. An attentive observation of the symptoms experienced by the patient; an examination of the multiplied causes which could give rise to them; the information furnished by the attendants, respecting the mode of life of the patient; such are the resources from which the juridical physician must draw his conclusions in this case, at all times difficult, and which demands, on the part of the practitioner, the most profound sagacity.

FOURTH CASE.

The Person is dead.

154. Many learned men of Germany have laboured at the solution of the problem which is now before us: this subject has always appeared to them to deserve the greatest attention, as it ought to throw a light upon medical jurisprudence. We will explain in a few words the principal proceedings recommended by them, before pointing out that which appears to us to unite the greatest advantages.

Process of Hahnemann.

155. 1st, The greatest quantity possible of the substances contained in the stomach should be procured: 2ndly, they should be made to boil for six hours in water; this should afterwards be filtered and saturated with an acid, if it is alka-

line, and with an alkali, if acid: 3dly, lastly, this liquor should be brought in contact with sulphurated hydrogen, with ammoniacal copper (a solution of the oxyde of copper in ammonia), and with lime-water perfectly saturated. This process, followed for a long time by physicians, presents two inconveniences: in the first place, the author contents himself with boiling the suspected matter in simple water; we shall shew presently that this fluid is sometimes not sufficient to carry off the arsenious acid, when strongly combined with animal substances. In the second place, the most essential characteristic, that which has for its object the reduction of this acid to the metallic state, is here completely neglected.

Process of Rose.

156. According to this method, which was published in 1806; if the arsenious acid be not found in substance amongst the suspected matter, the stomach must be cut into pieces, and boiled for some time in water, adding from two to four drachms of caustic potash: by this means the stomach becomes partly decomposed and dissolved, and the arsenious acid with which it might be combined, is saturated by the alkali. In this state the liquor is filtered, which is of a colour more or less dark; it is then boiled, and nitric acid added a little at a time, until it become of a clear yellow colour: the acid decomposes and destroys the animal matter. It is then filtered afresh, and the excess of acid in the fluid is saturated with an alkaline carbonate: this is boiled, to expel entirely the carbonic acid, and precipitated by lime-water boiling; the precipitate, which is formed, contains arsenite of lime; and perhaps a little arseniate proceeding from a transformation of a portion of the arsenious acid into arsenic acid, by means of the nitric acid. This precipitate must be washed; it is then dried and heated to redness in a small retort, coated with a lute made of clay and sand: the arsenic soon sublimes in the metallic state.

Rose recommends the calcining this precipitate of the arsenite with half a part of the boracic acid, in order to favour the separation and decomposition of the arsenious acid. By following this process, the author succeeded in extracting the metallic arsenic from $\frac{1}{8}$ of a grain of the acid which he had purposely mixed with animal substances.

This method of reducing the arsenious acid to its metallic state appears to us very good, especially when the examination is made of a dead body which has been long under ground, and the acid is intimately combined with the animal matter. M. Roloff has objected* that it would be more convenient to operate first upon the materials contained in the stomach, in order to pass afterwards to the chemical examination of this viscus; for by taking the whole, there is a risk of losing the *corpus delicti*, if the retort should chance to break during the sublimation. This objection, however, is of no great weight, as Fischer remarks; in fact, the whole quantity of the arsenite of lime, obtained by the process of Rose, may be divided into two parts; one of which may be calcined, and the other preserved, in case the operation should not be attended with the success desired.

Process of Roloff.†

157. This learned man, as we have just observed, wishes that the stomach and its contents should be separately examined: he recommends the treating it at first by the nitric acid, and afterwards by the caustic potash, which is just the reverse of Rose's method. The fluid obtained by this proceeding should be filtered and precipitated by the sulphurated hydrogen; whilst, in the preceding method, it is treated by lime-water. Lastly, the precipitate of sulphuret of arsenic, being calcined, furnishes metallic arsenic. This process, in many respects good, presents, however, an inconvenience,

* *Mémoire* quoted by Fischer, p. 78. † Ibid.

which is, that the sulphuret of arsenic obtained by means of the sulphurated hydrogen, sublimes, in a great degree, while calcining, which prevents the entire revival of the metallic arsenic. In an experiment made by M. Roloff, 2,25 grains of this precipitate furnished only 0,125 of metallic arsenic, that is to say, somewhere about the twentieth part of the weight of the precipitate, a quantity far short of representing that which ought to have been obtained.

Process of Fischer.

158. M. Fischer recommends the following operations: 1st. To treat the suspected mass with water, potash, and nitric acid, as pointed out by Rose. 2nd. To examine the liquor obtained, by lime-water, sulphurated hydrogen, ammonical copper, and the mineral cameleon. 3d. To sublime, according to Rose's method, the precipitate formed by lime-water in a portion of this liquor. 4th. To expose a part of it to the action of the galvanic pile. 5th. To ascertain whether the metal obtained by calcination of the arsenite of lime, and by the galvanic pile, diffuses a smell of garlick, on being thrown upon burning charcoal.

A Method for discovering the Arsenious Acid, after the Death of a Person poisoned by this Substance.

159. After having detached the alimentary canal in the manner we have pointed out § 173, the contents of the stomach, liquid or solid, should be collected. If any portions of arsenious acid are perceived in them, they should be separated and analysed by the methods shewn § 151; if these materials, however, do not contain any, the liquid part should be strained through fine linen, and examined in the manner we have pointed out when speaking of the matter vomited. Lastly, if after all attempts the poison should not be discovered, the solid materials must be operated upon: but the lesions of texture of the alimentary canal should be previously noticed, and

the stomach detached, and cut into small pieces, which should be kept in alcohol, to preserve them from putrefaction.

The solid parts should then be made to boil for an hour, in ten or twelve times their weight of distilled water, which should be renewed as fast as a portion of it flies off in vapour: this liquor should be cooled and decanted, in order to put a few drops of it into the solutions of sulphate of ammoniacal copper, of lime-water, of hydro-sulphuret of ammonia, of nitrate of silver, and of the mineral cameleon. If the precipitates furnished by these tests induce a belief that the solution contains arsenious acid, it should be mixed with potash, evaporated, and the product obtained calcined with charcoal, to extract from it the metallic arsenic (§ 151, A). If, on the contrary, the fluid offers no indication of poison, the mass exhausted by water should be treated with potash and nitric acid, as recommended by Rose (§ 156). When, by this means, a fluid has been obtained of a clear yellow colour, the excess of acid should be saturated with potash, and an arsenite of potash is thus formed, if there really exists any arsenious acid in the mass. This liquor should then be examined by the tests we have spoken of, which are capable of discovering the most minute atoms of arsenious acid, or of the arsenite. If the precipitates they furnish be of a nature to induce a suspicion of the existence of this poison, it should be precipitated by the hydro-sulphuret of ammonia, and by a few drops of nitric acid: a yellow sulphuret of arsenic is by this means procured, from which the whole of the metal may be obtained, by drying it upon a filter, mixing it with an equal bulk of potash, and melting it in a small glass tube, (*fig. 3.*) (§ 120).

If after having thus treated the solid matter, the arsenious acid should not be discovered, the same experiments should be made upon the stomach itself.

The plan we have just laid down differs from that of Rose, by the employment of the hydro-sulphuret of ammonia, which precipitates the poison in the state of sulphuret of arsenic,

whilst this philosopher transforms it into arsenite of lime: now, the sulphurated hydrogen is a test much more sensible, and deserves the preference.

160. The line of conduct we have just marked out, will require to be modified in such cases where the patient may have already swallowed sulphurets or hydro-sulphurets for the purpose of decomposing the poison, or of preventing the developement of the symptoms which usually result from it. In fact, if the arsenious acid has been decomposed by these tests, it will have been transformed into a yellow sulphuret of arsenic, the properties of which differ from those of this acid. In that case it will be necessary to have recourse to the following method.

1st. If the stomach only contains alimentary matter in a liquid state, they must be collected and allowed to deposit all the yellow parts insoluble in water, which should be dried upon a filter, and a portion of them put upon burning charcoal; there will be instantly disengaged a mixed smell of sulphureous acid (a smell of burning brimstone), and of arsenious acid (a smell of garlic).

A part of this body, perfectly pulverized, should be washed with an equal bulk of potash of commerce dried, and the mixture should be heated in a glass tube (*fig.* 3); the metallic arsenic will speedily sublime, and sulphate of potash will be obtained at the bottom of the tube (§ 120). These characters are sufficient to determine that the powder submitted to the analysis is sulphuret of arsenic. The writers on medical jurisprudence advise the digesting this sulphuret in muriatic acid, to which a little nitric acid is added; in this case a yellow powder is obtained, which is only sulphur and a solution of muriate of arsenic. The metallic arsenic in this case is oxydized by a part of the oxygen contained in the nitric acid, and converted into a muriate by its combination with the muriatic acid. This property appears to us a little complicated, and difficult to ascertain with certainty; for it sometimes hap-

pens, that there is no residue, the whole of the sulphur being transformed into sulphuric acid, at the expense of a portion of the oxygen of the nitric acid: this phenomenon takes place when a little too much of this acid has been employed, and especially when it is extremely concentrated. Even when this yellow powder is obtained, it is necessary to analyze it, in order to discover if it be really formed by sulphur, or by a portion of the yellow sulphuret of arsenic not acted upon. Lastly, that the operation may be complete, it is necessary that the metallic arsenic be separated, by mixing the solution of muriate of arsenic with alcohol, and bringing the mixture in contact with a plate of zinc.

2nd. If solid matter in the stomach be found mixed with some particles of yellow sulphuret of arsenic, two drachms of potash of commerce must be added, and it must be evaporated in a capsule of porcelain; the mass obtained must then be detached, pulverized, and calcined in a glass tube (*fig.* 3), in order to obtain the metallic arsenic, which will be volatilized, and attach itself to the sides of the tube. If the whole quantity cannot be contained in the tube, the revivification may be effected in a retort of stone coated with a lute, to which a *bitubulated* receiver should be adapted, to the end that the gas proceeding from the decomposition of the animal matter, may escape by one of the tubes.

161. Before finishing our remarks on the chemical researches necessary to detect the presence of the arsenious acid, we ought to observe, that it may happen after the death of any person poisoned by this acid, that we cannot arrive at the demonstration of the existence of the poison, whatever care may be taken in the analysis of the substances contained in the stomach. M. M. Thomas Jones, and Wikely report, in the London Medical Journal, that a young woman died after having swallowed a certain quantity of arsenious acid mixed with sand: the stomach contained about half a pint of fluid of a reddish brown colour; the mucous membrane of this viscus,

inflamed and destroyed, was in some parts adhering to the other coats, and in others detached. The adhering portions were of an ash colour, hard to the touch as though they had been cauterized, and presented to the naked eye a white powder, which was nothing but sand. The œsophagus and the mucous lining of the intestines were inflamed, the rest of the viscera were in a sound state. Nevertheless, all the chemical attempts to demonstrate the existence of the poison were ineffectual. It is probable that the patient, to whom great quantities of warm water had been given, had thrown up the arsenious acid by vomiting. I have satisfied myself, that all the animals that had taken this poison dissolved in water, and had abundant vomitings before death, do not exhibit the least trace of arsenic, when the contents of the stomach are submitted to chemical analysis. M. Brodie has observed the same fact. In cases like these, it becomes necessary to have recourse to the analysis of the matter vomited, and to proceed as has been said § 152.

TREATMENT OF PERSONS POISONED BY ARSENIOUS ACID.

162. We shall observe the same method in the treatment of this kind of poisoning, as that we have adopted when speaking of the means for remedying the symptoms resulting from corrosive sublimate.

Does there exist any antidote to the arsenious acid? M. Renault (in the work before quoted) has instituted a series of experiments to determine the value of several chemical tests; such as the alkaline, or ferruginous sulphurets, the acetic acid, and sulphurated hydrogen, which have been proposed as antidotes to this substance. We shall give an account of the interesting results obtained by the experiments of this physician.

Experiment 1st. By the assistance of an elastic gum catheter, two grains of arsenious acid were introduced into the sto-

mach of a middle-sized dog, with ten ounces and a half of water which held in solution three *grammes* (about forty-six grains) of sulphuret of potash: the whole had been mixed two hours before. Twelve or fifteen minutes afterwards, and for the space of an hour and a half, the vomitings were so violent and abundant, that the liquor was almost wholly expelled from the stomach; respiration became difficult; the animal uttered plaintive cries, had two evacuations, passed some urine, and died four hours from the injection of the poison.

On opening the body, the stomach was found slightly livid on its exterior surface; it was inflamed in the inside only near the pylorus. The duodenum and the beginning of the jejunum exhibited some red spots at a distance from one another: the inflammation affected, in some degree, the other small intestines both within and without.

Experiment 2nd. Four grains of arsenious acid in solution, and the same quantity of sulphuret of potash as in the preceding experiment, mixed at the moment, were injected into the stomach of a middle-sized dog: he almost instantly made violent efforts to vomit; and threw up a portion of the liquor, as well by the nostrils as by the spaces between the teeth.* Shortly afterwards he had copious evacuations, both by stool and vomiting; his strength entirely failed, the animal fell into a sort of syncope, and died seven hours and a half after the injection. On opening the body, the lungs were found in their natural state: the stomach contained about a pound and a half of fluid, turbid, and of a brown colour; the internal coat of this viscus, which was livid and almost black, was, as it were, doubled by a false membrane of a deepish yellow colour. The great quantity of thickened mucosities which were found in the small intestines, had apparently protected them from the action of the poison; for the great intestines, which had no such defence, were inflamed, whilst the others were not.

* *Quære.* Was the dog muzzled? or, why was the liquor only passed between the spaces of the teeth, and through the nostrils?—*Translator.*

Experiment 3rd. A young dog of middle size took three grains of arsenious acid in a fluid state, mixed with three *grammes* (forty-six grains) of sulphuret of lime dissolved in twelve ounces of water. He began to vomit in about a quarter of an hour, and the whole of the liquor was expelled from the stomach in the space of three hours, whilst at the same time it produced the effect of a violent purgative.

The product of the vomiting was collected, and injected afresh, and returned almost instantly by the anus, without having experienced any apparent change. The animal died half an hour afterwards.

The stomach exhibited a false membrane, which concealed the mucous coat from view: this last throughout its whole extent, had a livid appearance, which was deeper towards the great curvature: the intestines were filled with a thick mucus, and inflamed throughout their whole length.

Experiment 4th. The precipitate obtained by decomposing four grains of arsenious acid by a sufficient quantity of hydrogenated sulphuret of lime, was given to a dog. This precipitate was diluted with water. The animal made great efforts to vomit, but they succeeded in forcing all the fluid to return into the stomach. He died in five hours time, after having passed two or three stools, and uttered plaintive cries for above the space of an hour.

The stomach contained more than a pound of fluid; the mucous membrane was of a deepish red colour, and covered with a coat of viscous semi-transparent mucosities. The intestinal canal was slightly inflamed throughout its whole extent.

163. These experiments are sufficient to demonstrate the inutility of alkaline sulphurets in cases of poisoning by arsenious acid. In fact, the animals die in as short a time, and even shorter, when this pretended antidote is administered than when they take the arsenious acid by itself.

Dr. Vandendale, physician of the civil hospital of Louvaine,

reports a case of poisoning by the arsenious acid, the cure of which, it appeared to him, ought to be attributed to the sulphuret of potash: which does not at all accord with the experiments we have just been speaking of. The case is this:

Filia xxvi *annorum, temperamenti melancholici, et irrequietæ conscientiæ fluctibus jam per aliquot annos agitata, in omnibus bene ratiocinans, sed in eo solum delirabat, quod se crederet esse sub potestate dæmonis ipsam continuo persequentis, summo mane ad lectum laqueo se suspendit, fratres tumultu expergefacti inveniunt sororem suspensam et moribundam: omnibus adhibitis tandem revixit; post duos menses se occidendi causâ, assumpsit ad minimum drachmam unam et semis arsenici fortissimi; inveni ipsam inflato toto corpore sursum et deorsum evacuantem cum fœtore intolerabili et meteorismo abdominis frigidam instar cadaveris; tanta fuit vis veneni, ut non tantùm tempore decem dierum per alvum secederent primarum viarum involucra, sed et ipsa cuticula abscederet a capite ad pedes, cum defluvio capillorum et perditione unguium manuum et pedum, ut verè esset horrendum monstrum; tardiùs accedens evacuantia dare non potui, cum jam primæ viæ tantæ quantæ essent inflammatæ; sola ergo obvolventia per os et anum administravi; sola salus fuit in hepate sulphuris, quod per quatuor septimanas sumpsit ad drachmas duas de die in decocto hordei; quibus sensim evasit ægra instar miraculi, et perfectissime fuit sanata; cum tamen inhæreret infelicibus ideis sibi vitam adimendi, familia ejus ipsam conduxit ad Gheel* (a place where lunatics are confined); *sed, proh dolor, vix per mensem ibi morata, se precipitavit in puteum, in quo inventa est mortua, victima irrequietæ conscientiæ, tantorum malorum et triplicis tentati suicidii.**

Notwithstanding the reputation which M. Vandendale justly enjoys, we cannot believe that the cure of this poisoning ought

* Manuel de Toxicologie de Franck, p. 38. Translator's note, *Anvers*, 1803.

to be attributed to the sulphuret of potash; it is extremely probable that the whole of the arsenic was expelled with the matter of the vomitings and stools, which the patient had already had in great abundance, when the physician was called in. Besides, this case is not sufficiently precise: it would have been necessary, before appreciating the effect of the sulphuret of potash, to have ascertained whether the stomach was empty or full at the time of the taking the poison, what was the nature and the quantity of the matter vomited, what were the symptoms observed before the day when the sulphuret of potash was administered, at what period this medicine was first given, and what action did it produce, &c. &c. In short, a fact of this nature, however exactly it may be reported, is not sufficient to counterbalance the experiments of M. Renault, and the author is very right in considering this cure as miraculous *(instar miraculi)*.

164. The sulphurated hydrogen, extolled by several physicians, has been equally the object of investigation by M. Renault; and it may be said that it has furnished results much more satisfactory than the sulphurets we have been speaking of.

Experiment 1st. Four grains of arsenious acid in solution, mixed, twelve hours before the experiment, with fourteen ounces of water charged with sulphurated hydrogen gas, were injected into the stomach of a great dog; the first day he experienced neither nausea or uneasiness; the next morning he appeared a little sad and melancholy, and shewed no inclination to eat; but the appetite returned to him again in the evening; and the third day his health was perfectly re-established.

Experiment 2nd. Eight grains of arsenious acid in solution, mixed at the moment of injection, with fourteen ounces of hydro-sulphurated water, were given to a middle-sized dog. For fifteen hours he had a great deal of eructation, and passed

a quantity of limpid foam, drawn out into threads; but it was only during the night that he threw up about one-fourth of the whole quantity of liquid injected. The next morning he shewed signs of appetite, and his health appeared not to have sustained the least injury.

Experiment 3d. Similar results were obtained with another dog that had taken 10 grains of arsenious acid.

Experiment 4th. Five grains of arsenious acid in a fluid state were injected into the stomach of a great dog; a few minutes after, ten ounces of the hydro-sulphurated water were introduced. In less than a quarter of an hour he threw up about a fifth part of the liquor injected. In a short time he had every appearance of being very well; be began to eat the same evening: the next day he seemed dejected; but he had such an appetite, that he devoured almost entirely a little dog that had just died beside him.

Several other dogs into whose stomachs the hydro-sulphurated water had been injected a few minutes after they had been made to swallow the arsenious acid, have exhibited similar results.

165. From these experiments we may conclude, that the new body formed in the stomach by the sulphurated hydrogen, and arsenious acid in a liquid state, may be taken with impunity in tolerably strong doses. Now if we consider, 1st, That hydro-sulphurated water can be taken in a large dose without any inconvenience. Secondly, That it acts upon the arsenious acid in a liquid state, at a temperature below that of the human body. Thirdly, And that its action is prompt:—we shall be forced to conclude, that it is the antidote to the arsenious acid in a liquid state. But is the case the same when this poison has been taken in a solid form? The experiments made by M. Renault, prove, that, in this case, it is of no use: and as, unfortunately, poisoning by arsenious acid generally takes place from solid arsenic, it may easily be con-

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ceived, that the use of the sulphurated hydrogen gas will be of very little practical advantage. We shall report two experiments in support of this last assertion.

1st. Eight grains of arsenious acid in an impalpable powder were mixed with ten ounces and a half of hydro-sulphurated water: the two substances were agitated together for some time in a flask well stopped, and an hour afterwards introduced into the stomach of a dog above the middle size. He only began to vomit at the end of two hours and a half, and the vomitings continued during five hours: he uttered plaintive cries and groans till the moment of death, which took place twelve hours after the injection. The stomach contained above a pound of a blackish fluid tolerably clear, and which had a smell resembling bile: it was only inflamed along the course of its long curvature. Of all the intestines, the duodenum alone had its mucous membrane inflamed.

2nd. The same mixture as that we have now been speaking of, was given to a dog bigger than the one last mentioned: he vomited five times during the first three hours, and died at the expiration of fifteen or eighteen hours, without shewing the smallest sign of pain.

The stomach, and the fluid contained in it, presented the same appearances as in the foregoing experiment: the duodenum and pylorus in no way partook of the inflammation of the stomach.

166. After having thus determined the value of the alkaline sulphurets, and of the sulphurated hydrogen, considered as counter-poisons, M. Renault observes justly, that vinegar, which is reckoned amongst the antidotes to arsenious acid, is not capable of dissolving this acid at a low temperature, that the solution only takes place at the degree of ebullition; and that the salt resulting from it, which is only an acetate of arsenic, is altogether as caustic as the arsenious acid, which is sufficient to strike out this substance from the list of antidotes to this acid.

These experiments prove, that the agents hitherto recommended as antidotes to arsenious acid, when employed, as it almost always happens, in a solid state, do not deserve that title; they ought consequently to be rejected from practice in this kind of poisoning, in order to have recourse to other substances whose operation is more certain and easy.

167. The first care of a physician called to the assistance of a patient poisoned by arsenic, is to favour the expulsion of the poison by vomiting. The means to be made use of are nearly the same as those we have laid down whilst speaking of corrosive sublimate; and which consist in administering great quantities of warm water, milk, water sweetened with sugar or honey, decoctions of linseed, marshmallows, mallows, &c. &c. The tickling the throat with a feather, or with the finger, ought not to be neglected; it often enough happens that this treatment alone is sufficient to calm the symptoms.

168. M. Marcelin Duval reports, that having been called to a man who had taken some arsenical powder, he found him in a violent state of agitation, complaining of tearing pains of the stomach, a burning thirst, and constriction of the throat. He caused him to drink, at different times, two pints of sugared water. Frequent vomitings came on, and all the symptoms became calm. The same kind of drink was continued during the night, and two glysters of the same nature were prescribed for him: the next day he was in a state to go about his ordinary employment. In another instance, M. Duval introduced into the stomach of a dog, twenty-four grains of arsenious acid dissolved in six ounces of water: half an hour after, the animal was tormented by vomitings of a frothy matter, and excessive agitation. Water sweetened with honey was injected from one quarter of an hour to another, until all the symptoms disappeared, which happened immediately after the eighth and last injection. On the third day he was perfectly well.*

* Op. citat. p. 36 and 37.

I have often repeated this experiment, substituting warm water for the water sweetened with honey, or sometimes broth, or some mucilaginous decoction; and I have always obtained the same results.

169. The celebrated author of the *Nosographie Philosophique*, reports the case of a woman who had taken arsenic with the intent of killing herself.

" Having received succour in time, by the copious use of " milk, mucilaginous drinks, veal broth, chicken broth, and " fomentations, she escaped death; but her existence is still " the most distressing, and the most painful. The symptoms " she experiences are, anxieties, an irregular febrile state, dry- " ness of the skin, an aridity of the tongue and throat, a very " ardent thirst, painful respiration, deep-seated pain in the " region of the stomach, tension of the abdomen, obstinate " constipation, spasmodic constriction of the extremities, with " wandering pains in the pudenda. I have insisted much on " the use of drinks sweetened with sugar or honey, or even " sugar in substance, and this treatment has been followed " with very evident relief; but is it in the power of medicine " to repair the disorders produced in the texture and structure " of any of the viscera by a poisonous substance?" *

170. We could quote, in support of the treatment we have just described, a fact generally known, and which is, that the symptoms arising from the use of arsenious acid, and, in general, from all the corrosives, are so much the less severe, as the stomach happens to be filled with a greater quantity of solid or liquid matter; the poison, in that case, being disseminated over a greater extent of surface, and especially the vomiting being more easy. The following facts will put this truth beyond all doubt.

1st. A number of persons being at a feast, there was served up at the dessert, a dish, into which arsenic had been put instead of flour. Such of the guests as had, till then, eaten

* Nosographie Philosophique, tom. ii. p. 225. 3d edit.

but little, died of it instantly; while those, on the contrary, who had the stomach full, were saved by vomiting.*

2nd. Three children, one of which was a male of two years of age, who had been sick, and two adult girls, ate of a pottage in which there was arsenic. The boy, who took only two spoonfuls, had no vomiting, and died; the girls, who ate all the rest, vomited, and were saved.†

3d. Two chambermaids were living with the same master; one of them conceived such an inveterate jealousy against the other, that she resolved on her destruction. The way of poison appearing to her the most certain, and least likely to discover her, she gave it the preference to all others. In consequence of this, she put every day into her rival's broth a small quantity of arsenious acid in powder. A few moments after dinner, the food and the poison were both vomited, before the latter had sufficient time to act upon the stomach, so as to produce any serious accidents. Nevertheless, as the same thing was repeated every day for the space of six weeks, the stomach, in the end, acquired an excessive degree of sensibility; she felt severe pains of the bowels, and wasted to an extreme degree of leanness; spittings of blood succeeded; the general irritability increased to such a degree, that a simple current of air was sufficient to produce spasms and convulsions. At length, being arrived at such a pitch that the stomach could no longer bear any thing, the patient went into the country, where she staid two months. Her health there gradually improved: her digestion began to be less painful, and more complete: she resumed her healthy appearance, and returned to the capital to her ordinary employment. Her implacable enemy, desperate from the little success of all her attempts, and fearing lest her victim should escape her, put one morning into her coffee a very strong dose of arsenious acid in powder.

* De Sedibus et Causis Morborum, Morgagni, Epist. 59, No. 4, tom. iii. p. 246.

† Idem, p. 245.

There immediately resulted from it violent vomitings, which soon expelled from the stomach both the breakfast and the poison. It was then that the matter became certain, that all her former vomitings, and those which had just taken place, were owing to the arsenious acid. This poison, being collected in the matter vomited, was recognized for such by an apothecary of Paris. The unfortunate chambermaid, however, reduced by this fresh poisoning, and by ill-directed care, to the most deplorable condition, was confided to the care of Dr. *Beauchesne*, a distinguished practitioner of the metropolis, who succeeded in restoring her to health.*

4th. *Mauritius Hoffman* speaks of a quack, on whom twelve grains of arsenious acid produced little or no inconvenience, because he drank before it a great quantity of milk, which was quickly vomited, together with the poison.†

171. In case the patient can no longer vomit, it will be necessary to have recourse to the elastic gum tube, which we have described § 84. These means ought always to be preferred to the use of violent emetics, such as tartarized antimony and sulphate of zinc, which never fail to increase the irritation produced by the poison.

172. Fat substances, such as oils, butter, cream, grease, &c. are of no kind of use; they are even dangerous. This fact was first announced by Fourcroy, and Renault verified the correctness of it by direct experiments. All the animals to which he gave arsenious acid in butter or grease, died sooner than if they had swallowed the poison alone, or mixed with any other substance.‡

173. Lime-water with milk, recommended by Navier, offers no particular advantage in cases of poisoning by arsenious acid taken in a solid form. All the animals to which I gave it, died in the course of a few hours. The same thing,

* Renault, O. C. p. 86.

† Miscellanea Curiosa, Appendix, Obs. xxxviii. 1772.

‡ Op. citat. p. 91.

however, does not happen, if the arsenious acid was in a fluid state; in this case there is formed an insoluble arsenite of lime, which acts very feebly. I have given to small dogs, as much as four grains of this poison in a liquid state, and have made them swallow lime-water: they were not incommoded by it. The difference evidently depends on this, that in the first case, the lime unites difficultly with the arsenious acid in a solid form; whilst, in the second case, these two substances, meeting in a state of fluidity, combine easily, and form an insoluble body, which does not appear to act as a poison. But, as it is generally in a solid form that the arsenious acid is swallowed, the utility of the lime-water becomes null.

174. The theriaca, boasted of formerly as an excellent remedy in this kind of poisoning, ought to be rejected as useless and dangerous. Navier reports a case of six persons poisoned from eating broth in which was arsenious acid; a great quantity of theriaca was administered as their first remedy: they all died in eight days time, except one, who did not die till two months after, because she had eaten very little of the poisoned broth. On opening their bodies, the coats of the stomach and intestines were found to be destroyed, by the falling of the sloughs which the poison had produced.*

175. The infusion of cinchona *calissaya*, of galls, of fir bark, of the Pomegranate, of the *myrobolan (Indian nut)*, &c. &c. recommended by M. Chausarel, are only useful in consequence of the vehicle which forms a part of them; they do not exert sufficient energy upon the arsenious acid, to be considered as antidotes to this substance; and it is consequently preferable to have recourse to warm water, which has the advantage of being administered instantly, and in great quantity.

Leeches, bleedings, baths, tepid demi-baths, fomentations, emollient glysters, antispasmodics, and narcotics, are all so

* Navier, op. citat. tom. i. p. 17 et 169.

many means which ought to be had recourse to, in cases where inflammation of the abdomen has already taken place, and where the patient is a prey to alarming nervous symptoms.

It must never be forgotten, that the success of the treatment depends in a great measure on the sort of regimen the patient observes during his convalescence, which is commonly long and painful. He ought to be principally nourished by milk, gruel, and rice-creams, and he should be made to take nourishing drinks.

OF THE ARSENITES.

176. The arsenites are combinations of the arsenious acid with salifiable bases: those of potash, soda, and ammonia, are soluble in water, and act as violent poisons: that formed of potash merits our particular attention, because it forms part of the solution of Fowler, employed in certain cases of intermittent fever.

177. The arsenite of potash is generally met with in a fluid state; when dried and put on burning coals, it becomes decomposed, diffuses a smoke with a smell of garlic, and leaves for a residue, potash more or less carbonated.

178. The hydro-sulphurets, the salts of copper, lime-water, and nitrate of silver, act with this arsenite as with the arsenious acid (§ 120 and *seq.*).

179. The arsenite of potash being mixed with muriatic acid, gives a white precipitate of arsenious acid, and a soluble muriate of potash is formed; this precipitate easily re-dissolves in an excess of water; from which it may be concluded, that in order to obtain it, the solution of the arsenite should be concentrated.

180. Muriate of platina throws down a canary yellow precipitate with the solution of this salt; whilst, as we have observed, arsenious acid does not experience any change from this metallic solution. The precipitate formed in this case is

a triple salt, composed of muriatic acid, oxyde of platina, and of potash.

181. In order to separate the metallic arsenic from the arsenite of potash, the salt should be evaporated to dryness, mixed with charcoal, and calcined in a small glass tube (*fig.* 3), the metallic arsenic being separated by the charcoal from the arsenite, sublimes, and condenses on the sides of the tube.

OF THE ARSENIC ACID.

182. The arsenic acid in a solid state is white, not crystallizable; of a sharp, metallic, and caustic taste: its specific gravity is 3.391.

183. Exposed to the action of heat in a closed vessel, it does not become volatile, but melts and vitrifies.

184. Thrown on burning charcoal, it swells out, loses all its moisture, and becomes opaque; if in this state the heat is continued, it gives out white vapours, which exhale a smell of garlic. These phenomena are the consequence of its decomposition by the charcoal, and its transformation into arsenious acid; for which reason it disappears altogether. A plate of copper held over these vapours becomes white, precisely in the same manner as with the arsenious acid.

185. The arsenic acid dissolves exceedingly well in water; it is even deliquescent: therefore in solution, it strongly reddens the tincture of tournesol, and the syrup of violets; it is colourless and sapid.

186. It forms soluble salts with potash, soda, and ammonia: on the contrary, it gives a white precipitate with lime-water, and water of barytes. These insoluble arseniates re-dissolve easily in an excess of arsenic acid.

187. The sulphurets, hydro-sulphurets, and hydrogenated sulphurets, are decomposed by the arsenic acid, as by other strong acids. Sulphurated hydrogen gas is disengaged, and a whitish sulphur, slightly yellow, is deposited.

188. Nitrate of silver is precipitated in a pulverulent form; the precipitate, which is of a brick colour, immediately collects, and resembles a very deep kermes. The lunar caustic likewise effects this decomposition; in either case there is formed an arseniate of silver, and the nitric acid is set at liberty.

189. Sulphate of copper is not disturbed by this acid. The acetate of this metal gives instantly a bluish white precipitate: the same thing takes place with the sulphate of ammoniacal copper, unless, that with this triple salt, the precipitate produced is less abundant. These precipitates are formed by the arseniate of copper, the colour of which differs essentially from the arsenite of that metal (§ 123).

190. The arsenic acid does not produce any action, either on the muriate or acetate of cobalt; but it gives a rose-coloured precipitate with the muriate of ammoniacal cobalt: this precipitate consists of the arseniate of cobalt. In order to obtain it, a concentrated solution of arsenic acid should be employed, of which only five or six drops should be used. In fact, if the water is slightly charged with acid, the precipitate would be blue, slightly inclining to violet, or a bluish rose-colour; because the muriate of ammoniacal cobalt, being capable of giving precipitates of these colours to water, would be decomposed by the great quantity of that fluid contained in the solution. On the other hand, if a great quantity of the acid be employed, the precipitate will be re-dissolved as fast as it is formed.

191. The arsenic acid in a solid form, mixed with charcoal and potash, furnishes metallic arsenic when heated in a small glass tube (*fig.* 3). The charcoal seizes on the whole of the oxygen contained in this acid, which is fixed by the alkali; and there is formed carbonic acid, which escapes in the form of gas.

192. The arsenic acid ought to be considered as a poison, still more violent than the arsenious acid. According to M.

Brodie, it is absorbed, and occasions death by acting upon the brain and the heart.

OF THE ARSENIATES.

193. The arseniates of potash, soda, and ammonia, are poisonous: they may be easily known; 1st. by the decomposition which burning charcoal effects in them, and by the smell of garlic which accompanies this decomposition: 2nd. by the rose-coloured precipitate which they furnish with the muriate of cobalt: this precipitate, which is formed by virtue of a double decomposition, dissolving easily in an excess of acid, would not take place in a very acid solution of the muriate of cobalt; 3rd. because they are not disturbed by the addition of muriatic acid, whilst the arsenites are precipitated; 4th. by the nitrate of silver, which will throw down a brick-coloured precipitate, consisting of the arseniate of silver; 5th. by the bluish white precipitates, formed by the salts of copper; 6th. lastly, by the facility with which the metallic arsenic is separated from them when calcined with charcoal.

OF THE YELLOW AND RED SULPHURETS OF ARSENIC.

194. The yellow artificial sulphuret of arsenic, ought to be considered as a poison, according to the experiments of M. Renault.

1st. Four grains of this sulphuret dry, and in a solid state, were given to a little dog, and vomiting prevented: the animal was violently purged, made many efforts to vomit, moaned, and died in five hours.

The mucous membrane of the stomach was red throughout its whole extent: the end of the ilium was more inflamed than the duodenum.

2nd. Three grains of the same sulphuret, were given to a dog larger than the preceding; vomitings, stools, moanings, and a considerable agitation, were the forerunners of death, which took place nine hours afterwards. On opening the body, the whole mucous membrane of the stomach was found inflamed: the small intestines, and especially the duodenum, presented here and there red spots.

195. This sulphuret may be easily known by calcining it with potash, in a small glass tube (§ 120).

196. The native orpiment (yellow sulphuret of arsenic) presents phenomena different to those we have been speaking of; it may be taken in a large dose, without occasioning the slightest derangement. M. Renault gave as much as two drachms of this substance to dogs of different sizes, that felt no inconvenience from them. Hoffman had already proved by experience the innocence of this substance, as may be seen by the following passage: *Jam verò auripigmentum omni drasticâ, purgante et emeticâ virtute caret, neque animantia necat, frequenti experimento instituto in canibus, felibus, quibus in insigni dosi ad drachmam unam et ultra sine ullâ subsequente noxâ id obtulimus. Arsenicum verò, sive album, sive flavum et rubrum, summum est venenum et omnis generis animantia in paulò majori dosi assumptum brevi necat. Ut adèo ex jam dictis satis clarè appareat, auripigmentum cum arsenico citrino neutiquam esse confundendum, quod tamen à plurimis medicis, imo collegiis factum esse, acta et responsa publica loquuntur.**

197. The native red sulphuret of arsenic can also be internally administered without any inconvenience resulting from it. M. Renault has given as much as two drachms to dogs, who did not appear to experience any uneasiness from it: the same thing by no means takes place with that produced by art. All

* Friderici Hoffmanni Op. Omnia, tom. 1. 1761, pars ii. cap. ii. de Venenis, p. 197. Genevæ, 1761.

the animals to which it has been given, even in doses of a few grains, have died within different spaces of time. A woman died in the course of a few hours, after having experienced violent gripings, in consequence of eating cabbages, with which a certain quantity of this substance had been mixed.*

198. The differences which the sulphurets of arsenic present, in respect to their action upon the animal economy, appear to us too striking, not to merit our particular attention. We see that the native yellow sulphuret, and that obtained by pouring the arsenious acid into the sulphurated hydrogen, do not produce any hurtful effect even in a strong dose (§ 165); whilst the artificial yellow sulphuret prepared by fusion, and that which is produced by the union of the arsenious acid, with an hydrogenated sulphuret, occasions death in a dose of a few grains (§ 134 and 193). The same thing takes place with the native and factitious red sulphurets.

It was thought for some time, that the composition of these sulphurets was not the same; that those formed by nature, furnished on analysis only sulphur and arsenic; whilst the others were formed of these two principles, united to a certain quantity of oxygen; and that it was because the arsenic happened to be in the state of an oxyde, that it produced its deleterious effects. This explanation, which beside does not embrace all the cases we have spoken of, falls of itself; since chemical analysis proves, that there is no oxygen in any one of these sulphurets, and that they only differ from one another, by a greater or less proportion of sulphur or arsenic.

I have attempted a great number of experiments, with the design of ascertaining what can be the cause of this difference; but the results I have obtained are too unsatisfactory to allow me to decide, until fresh inquiries shall have thrown a sufficient light upon the subject.

* Ephemerides Nat. Cur. vol. v. Obs. 102. p. 353.

OF THE BLACK OXYDE OF ARSENIC.

199. This oxyde is very easily known by keeping in mind all we have said respecting metallic arsenic. In fact, these two bodies possess nearly the same properties; their external appearance alone differs. The colour of the oxyde is a blackish gray, sometimes black; it is dull, without any brightness, not very hard, but extremely friable. Its poisonous action is put beyond all doubt, by the following experiments.

M. Renault gave to a little dog, six grains of black oxyde of arsenic finely levigated, and mixed with hog's lard. The animal was seized with vomitings four hours after having swallowed the mixture: the poison was prevented from being expelled from the stomach; but for two hours, the alimentary canal was in continual movement, and the alvine excretions were exceedingly copious. The animal quickly died.

The whole of the black powder was found in the stomach. The mucous membrane of this viscus, covered over with a coat of thickened mucus, was of the colour of the dregs of red wine. The inflammation did not extend beyond the two orifices, so that at two lines from them, the parts were in their natural state.

Four grains of the black oxyde of arsenic were given to another dog, bigger than the first, which were vomited up half an hour afterwards: he was made to swallow them afresh, and the greatest part was again rejected from the stomach, in about the same interval of time; it was not possible to make him retain it. In the last vomitings he threw up some bloody mucosities, and died at the expiration of ten hours from the poison.

The stomach was filled with a bloody fluid of a red vermillion colour: the mucous membrane shewed no traces of erosion; it was simply livid in a few places, and red over the rest of its surface. The intestines did not appear to have felt the least effect from the poison.

OF FLY POWDER.

200. Fly powder differs very little from the black oxyde of arsenic; it is nothing else than metallic arsenic a little oxydated, and is seen in the form of cakes, composed of layers irregularly arranged; from which it follows that, in order to recognise it, the same means must be employed which we have just now recommended for the black oxyde.

201. The following facts prove that this powder acts as a violent poison.

1st. M. Renault gave to a middle-sized dog five grains of this substance, and took care to make all that was expelled by vomiting return into the stomach. The animal continued to make useless efforts for five or six hours, without shewing any signs of pain: he fell, by degrees into a state of dejection, which became more and more considerable, and died at the expiration of eighteen hours.

The mucous membrane of the stomach was red, and inflamed throughout its whole extent, but in an unequal manner, and more so on its great curvature than in the other points. The portion of the alimentary canal nearest to the pylorus, equally partook of the inflammation.

2nd. A wine merchant of Rouen, breakfasting with five of his friends, drank with them a pint of wine; before the end of the breakfast they all experienced some unpleasant symptoms. One of the six died the next day; the five others were recalled to life, but their convalescence was long. M. Mezaize, apothecary at Rouen, found, by chemical ánalysis, that in the bottle in which the wine was contained, there was a black substance, which was nothing but fly powder.*

3d. Four persons of the same family were eating together at a meal some dried pears, which had been boiled with six drachms of the fly-powder. The father, fifty years of age,

* Rapport sur les Travaux de la Société d'Emulation de Rouen. Frimaire, an. 7.

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died at the end of thirteen hours: the eldest daughter, aged ten years, at the expiration of nine hours: another little girl of six years, did not die till after eighteen hours; and lastly, the youngest amongst them, aged two years and a half, who had only eaten what she had scraped out of the bottom of the sauce-pan, did not die till the sixth day. All these persons experienced gripings, vomitings, and cold sweats.

On opening the body of the father, they found the stomach inflamed; its internal surface exhibited red spots, and some plaits formed by extravasated blood.

The stomach of the eldest girl was equally inflamed, and contained liquid blood quite pure.

That of the child of six years old was less inflamed; but towards the pylorus its sides were thickened by blood that had oozed out.

Lastly, the stomach of the youngest child presented, on its *fundus*, an inflamed spot, the size of a bean.*

OF ARSENICAL VAPOURS.

202. The arsenious acid reduced to the state of vapour, and inspired into the lungs, produces serious symptoms, sometimes followed by death. Tachenius reports, that Hippocrates was attacked by a considerable cough, a great difficulty of breathing, severe colics, bloody urine, convulsions, &c. from having been for some time exposed to the vapours arising from an apparatus in which arsenic was subliming. The use of milk, and of oily substances, dispersed these symptoms; but there remained, for a long time after, a dry cough, and a kind of hectic fever. The use of cooling drinks, and cabbages for diet, put an end to these symptoms.†

* Acta Physico-Medica Acad. Cæsar. Nat. Cur. 1740. Obs. 102.

† Hipp. Chemic. Cap. xxiii. There is evidently some mistake in the original work here, which I have corrected rather at random, not having

"The arsenical vapours," says Mahon in his *Médecine Légale*, "when drawn into the lungs in great quantity, render "the mouth and throat dry, parched, and inflamed: they first "produce sneezing, then suffocation, asthma, dry cough, "anxiety, vomiting, vertigo, pains of the head and limbs, "tremblings: and when they do not produce death, they lead "to *phthisis pulmonalis.*"

ARTICLE III.

SPECIES III.—ANTIMONIAL POISONS.

Var. 1st. Tartar emetic, or antimoniated tartrate of potash.
—— 2nd. Oxyde of antimony, either by calcination, or by decomposition of the nitric acid or nitrates.
—— 3d. Kermes mineral, *golden sulphur of antimony*, beyond the medical doses.
—— 4th. The muriate and submuriate of antimony.
—— 5th. Antimoniated wine.
—— 6th. Other antimonial preparations.
—— 7th. Antimonial vapours.

203. The preparations of antimony, banished formerly from the materia medica by all such as formed exaggerated ideas of their hurtful qualities, were in the end sought after, and submitted to a rigorous examination by more enlightened and liberal practitioners. At this day, when their virtues are substantiated by the most severe observation, and by the experience of several ages, we see some of these preparations occupying the first rank among the noblest medicines and the most employed, on account of their utility and their constant manner of acting.

Their administration, nevertheless, requires, on the part of

the *Hippocrates Chemicus* of Tachenius at hand. It is there printed "*Hippocrates reports that Tachenius was attacked, &c.* The report is evidently that of Tachenius; but whether of Hippocrates, himself, or any other person, is doubtful.—*Translator.*

the practitioner, a great degree of circumspection; like all substances endued with energetic properties, they are capable of becoming fatal if inconsiderately employed. The most useful among them, the tartar emetic, too often, in the hands of empirics, may, under certain circumstances, produce the most unfortunate accidents, which may be followed by death. The case is the same with regard to the kermes, the golden sulphur, the glass of antimony, &c. as we shall shew in the sequel. These general considerations are sufficient to impress the importance of the study of this species of poisons.

OF ANTIMONY.

We think it proper to commence by a detail of the principal properties of metallic antimony; a knowledge of these will greatly abridge all that we shall have to say on poisoning by antimonial preparations.

204. Antimony is a solid metal, of a bluish white colour, brilliant, resembling silver or tin, and tarnishes very little in the air: its texture is lamellated, its hardness middling, nearly like that of tin. It is extremely fragile, and easy to powder. Rubbed between the fingers, it imparts to them a sensible smell. Its specific gravity is as 6.7021.

205. Exposed to the action of caloric, it enters into fusion at a little below a red heat; and if left to cool slowly, it forms a cake at the bottom of the vessel, the surface of which presents a crystallization, which has been compared to the leaves of the fern: it is not volatile, at least in any sensible manner.

206. Amongst the combinations which this metal is capable of forming with oxygen, there are two, the knowledge of which is useful to medical jurisprudence. One of these contains 20 parts of oxygen in 100, the other contains 30; both these are of a white colour. Being heated with charcoal in an earthen crucible, they are decomposed; the metal is revived, and carbonic acid gas is liberated.

207. Sulphur, oxygen, hydrogen, and antimony, are capable

of uniting in a certain relation, and forming two bodies known by the names of kermes and golden sulphur of antimony.

208. The nitric acid, heated with metallic antimony, converts it into a white mass, which no longer retains the metallic brilliancy, and which is nothing but the oxyde of antimony, containing thirty parts of oxygen. There is formed, during the action, a great quantity of red nitrous acid gas, which flies off; and nitrate of ammonia, which remains mixed with the oxyde.

Rationale. The nitric acid and water are partly decomposed: the oxygen of both acts on the antimony, and converts it into an oxyde. A part of the azote contained in the nitric acid is disengaged, with a portion of the oxygen in the form of nitrous gas; this gas becomes nitrous acid by its contact with the air: lastly, another portion of azote, which unites with the hydrogen resulting from the decomposition of the water, gives birth to ammonia, the combination of which, with the excess of nitric acid, explains the formation of the alkaline nitrate.

The white oxyde obtained, dissolves extremely well in muriatic acid, especially by the action of heat. The muriate which results from it gives a white precipitate with water, and an orange red with the hydro-sulphurets. The first of these precipitates is oxyde of antimony, retaining a little of the muriatic acid; a true sub-muriate of antimony; the second is a variety of kermes, or of the hydro-sulphurated oxyde of antimony.

209. Antimony, proscribed by the medicine of the day, is regarded by authors as a violent poison. Plenck asserts, that when it is inconsiderately taken, it produces vomiting, copious stools, intolerable gripes, anxiety, agitation, hæmorrhage, convulsions, inflammation of the stomach and intestines, erosion, gangrene, and death.*

* Op. Citat. p. 267.

It is probable that all these effects depend upon a small quantity of oxygen with which the metal combines when in the stomach.

OF TARTAR EMETIC.

210. The emetic tartar, known under the names of *antimoniated tartrate of potash*, of *stibiated tartar*, &c. is composed of tartaric acid, of oxyde of antimony at 20 p. 100, of oxygen, and of potash. According to the analysis made by M. Thenard, 100 parts consist of,*

Tartrate of potash	34
Tartrate of antimony . . .	54
Water	8
Lost	4
	100

The tartar emetic crystallizes in regular tetraedrals, or in triangular pyramids, or in elongated octaedrals. It is of a white colour; its taste is slightly metallic, and tart.

211. When heated red hot in an earthen crucible, it is observed to blacken and decompose in the manner of vegetable substances, leaving for a residue metallic antimony and potash slightly carbonated, of a white colour.

Rationale. The tartaric acid by the action of heat, being composed of oxygen, hydrogen, and carbon, is converted into several productions, amongst which, charcoal is the most abundant: the oxyde of antimony, in contact with this charcoal, yields it its oxygen in order to change it into carbonic acid; whilst, at the same time, the antimony remains in its metallic state, mixed with the portion of potash resulting from the tartrate of this decomposed base.

This experiment may be made by putting upon red hot

* Annales de Chimie, tom. xli. p. 51.

charcoal a certain quantity of tartar emetic pulverized: the result will be the same, only it will take place more promptly.

212. Tartar emetic exposed to the air effloresces.

213. It dissolves easily in distilled water. According to Buckal, 14 parts $\frac{2}{17}$ of this fluid, at the temperature of from 10, to 12° R. dissolve one part of this salt, and 100 parts of boiling water are capable of dissolving 53 parts, provided it be completely freed from tartrate of lime and tartrate of iron.* This solution reddens the paper and tincture of tournesol.

214. Sulphurated hydrogen gas, hydro-sulphurated water, and hydro-sulphurets, furnish with it an orange yellow precipitate when employed in small quantities; and a deep brown red, if employed in great excess. This precipitate is a combination of oxygen and antimony proceeding from the tartar emetic, and of hydrogen and sulphur proceeding from the re-agent employed. Being dried on a filter, and mixed with charcoal and the potash of commerce, it gives, by the action of heat, a cake of metallic antimony. This revival of the oxyde of antimony by charcoal may be effected in an earthen crucible, and continues scarcely ten or twelve minutes.

215. The concentrated sulphuric acid gives a white precipitate with the solution of tartar emetic: this precipitate, which consists of the oxyde of antimony retaining a little sulphuric acid, re-dissolves in a great excess of acid.

216. Potash with lime *(potasse à la chaux)* precipitates instantly this solution; and the oxyde of antimony precipitated re-dissolves easily in an excess of alkali.

217. Lime-water decomposes and precipitates abundantly the solution of tartar emetic; the precipitate is white, and extremely thick: it is composed of tartrate of potash and tartrate of antimony. The pure nitric acid re-dissolves it with facility.

* Annales de Chimie, tom. xlix. p. 70.

Rationale. The lime seizes on the tartaric acid of the tartrate of potash, forms an insoluble tartrate of lime; the tartrate of antimony, which was held in solution by the tartrate of potash, unites with the tartrate of lime, with which it subsides.

218. The water of barytes acts in the same manner with the solution of tartar emetic, except that the precipitate contains tartrate of barytes, instead of tartrate of lime.

219. The alkaline sulphates and neutral earths do not disturb at all the tartar emetic. If they are acid, as, for instance, alum, a precipitate is formed by reason of the excess of acid in the solution. This precipitate is of a milky white.

220. The carbonate of soda, put into this triple salt, gives a white precipitate, which collects easily together, and which consists of oxyde of antimony more or less carbonated.

221. The juices of plants, the extractive decoctions of woods, roots, barks, precipitate the solution of the antimoniated tartrate of potash: the reddish yellow precipitate furnished by them, is formed of oxyde of antimony and a portion of vegetable matter.

222. The infusion of galls in alcohol is the most sensible test for discovering the atoms of tartar emetic in solution. As soon as these two solutions are mixed, an abundant precipitate is obtained, curdled, of a dirty white colour inclining a little to yellow. This precipitate contains antimony more or less oxydated; for if it be treated by the nitric acid with heat, this acid will be decomposed, reduced to the state of nitrous gas, and there remains a white mass, in which the presence of the oxyde of antimony can be easily demonstrated by means of the muriatic acid. This acid furnishes a muriate which will give a white precipitate with water, and a red one with the hydro-sulphurets.

223. If a mixture be formed of ten parts of red wine, and one part of a concentrated solution of tartar emetic, the liquor preserves its transparency, and furnishes a reddish yellow precipitate by the addition of a few drops of the hydro-sulphuret

of ammonia, or of hydro-sulphurated water; if a greater quantity of these tests be added, the precipitate becomes green. The infusion of galls in alcohol produces a clear violet precipitate: lastly, the sulphuric acid immediately renders it turbid, and gives a sediment of a deep violet colour, which does not collect together till after several minutes. The same phenomena take place in a mixture of ten parts of wine and seven of a solution of tartar emetic: in this case only, the precipitates appear immediately, and they are of a deeper colour: that which results from the addition of a very great quantity of hydro-sulphuret is almost black. These experiments prove, that it would be impossible to recognise the tartar emetic mixed with wine, if we confine ourselves to the employment of those tests which are sufficient for discovering the smallest quantity of it when without mixture.

224. If one part of a concentrated solution of antimoniated tartrate of potash be added to ten parts of a strong infusion of tea, the mixture preserves its transparency, or else is very slightly disturbed. The hydro-sulphuret of ammonia gives a precipitate of a deepish red, which immediately collects in flakes: the sulphuric acid separates from it flakes of a white colour inclining to yellow: and the infusion of galls in alcohol disturbs it without occasioning any distinct precipitate. From which we may conclude, that this test is of no utility in discovering the atoms of stibiated tartar mixed with tea.

If the quantity of tartar emetic be more considerable, if the mixture be formed of six parts of this salt and ten of tea, the tincture of galls will produce a dirty white precipitate, the hydro-sulphurets a reddish orange, and the sulphuric acid a white, slightly yellow.

225. Albumine in solution, whether concentrated or diluted, produces no disturbance in the solution of tartar emetic. The mixture acts with the hydro-sulphurets and tincture of galls as if the tartar emetic were alone. Lime-water throws down a white precipitate, and this precipitate, which consists of tar-

trate of lime and tartrate of antimony, does not entirely disappear on the addition of pure nitric acid; for, in proportion as these two salts are dissolved by the acid, the albumine unites with it, and forms a white insoluble body which precipitates. The mixture of albumine and tartar emetic heated, gives a coagulum of albumine, and the supernatant liquor contains the tartar emetic.

226. When a solution of antimoniated tartrate of potash is mixed with gelatin, no precipitate takes place, whatever may be the quantity of gelatin employed. The mixture resulting from it yields an abundant precipitate to the galls: this depends upon a property which this infusion has of forming insoluble bodies with either of the substances which enter into its composition. The other tests furnish the same precipitates which they give with the simple solution of tartar emetic.

227. If a very small quantity of solution of tartar emetic be poured into milk, coagulation does not take place, and the mixture gives a clear red precipitate with the hydro-sulphuret of ammonia. If a very great quantity of emetic tartar is employed, a white coagulum is perceived; but, in truth, it is barely perceptible.

228. Broth does not in any way disturb the solution of emetic tartar.

229. The same thing takes place with human bile diluted with its bulk of water.

THE ACTION OF ANTIMONIATED TARTRATE OF POTASH UPON THE ANIMAL ECONOMY.

230. Ought this salt to be considered as a poison, capable of producing death?

Such is the question which we are about to examine, before seeking to determine what are the organs upon which it prin-

cipally exerts its action. M. Magendie, in his excellent memoir on tartar emetic, after having collected a number of interesting facts, concludes " that this salt, given in a large " dose, can produce very serious symptoms, and even death; " that if, in cases which frequently occur, men and animals " swallow, without inconvenience, very strong doses of tartar " emetic, that happens because the salt is rejected wholly in " the first efforts of vomiting." It would be not altogether useless to report the principal observations and experiments which have induced this physiologist to draw such a conclusion.

1st. All the dogs who took four, six, or eight grains of tartar emetic dissolved in water, the gullets of which were tied up to prevent vomiting, died at the end of two or three hours, from the introduction of this salt into the stomach. Those on the contrary, who were able to get rid of it by vomiting, have taken as much as a drachm, without experiencing, for the most part, any bad effect. When the dose has been increased to half an ounce, some were seen to perish at the end of a few hours, or a few days; and at other times, this large dose has occasioned no sort of accident.

2nd. Many observers worthy of credit, report instances of poisoning by tartar emetic, the effects of which have been by so much the more fatal, as the patients have experienced none or very little vomiting. Under other circumstances, on the contrary, strong doses of tartar emetic have only produced extremely slight symptoms, because the poison has been evacuated a few moments after its ingestion.

We read in Morgagni, and in the transactions of the *Curiosi Naturæ*, many cases in support of the innocence of tartar emetic under certain circumstances. M. Lebreton, one of the most distinguished accoucheurs in this capital, reports a case of this nature, perhaps the most extraordinary. Being called to attend the daughter of a grocer, who had just swallowed six drachms of tartar emetic, he caused her to drink a large glass of oil: she vomited immediately after, and

most probably threw up the whole of the salt she had swallowed. The vomitings a short time after ceased, and this girl was completely cured.

231. If the emetic tartar does act as a poison, in what manner does death supervene, and what are the organs affected? M. Magendie has made it appear, that the deleterious action of emetic tartar, shews itself principally upon the pulmonary texture, and the mucous membrane which lines the intestinal canal, from the cardia to the inferior extremity of the rectum. The following are the experiments on which he grounds his opinion.

When six or eight grains of tartar emetic, dissolved in three ounces of water, are injected into the veins of an adult dog of middle size, the animal vomits, and has frequent stools; his breathing becomes difficult, his pulse frequent and intermitting; at length a great degree of disquietude and slight tremblings are the forerunners of death, which takes place within the first hour from the injection or absorption of the tartar emetic. On opening the body, great alterations are perceived in the lungs; they are found of an orange or violet colour, have no crackling, are distended with blood, and of a tight texture; they are as it were hepatised in certain points of them, and very similar to the parenchyma of the spleen in others. The mucous membrane of the intestinal canal, from the cardia to the extremity of the rectum, is red, and strongly injected; it has evidently experienced the highest degree of inflammation.

If, instead of injecting six grains of tartar emetic, twelve or eighteen grains are introduced, death commonly takes place half an hour afterwards; and in that case, the lungs alone present indications of the action of the poison.

When only four grains of tartar emetic are introduced into the circulation, the symptoms are less severe, and take a longer time to develope themselves. The animals sometimes do not perish till after twenty-four hours; and on opening

them, the pulmonary alteration we have just spoken of, is found, and beside, a considerable inflammation of the whole mucous membrane of the intestinal canal, but principally of that which invests the stomach, the first of the small intestines, and the rectum.

232. If, instead of thus injecting the tartar emetic into the veins, it be injected into the stomach, and the œsophagus tied to prevent vomiting, the same alterations after death will be found, as those we have just explained.

233. Lastly, if the tartar emetic be brought into contact with the different absorbing surfaces, such as the convolutions of intestines, cellular substance, the proper tissue of the organs, vomitings and stools will be observed to take place, and death will happen at the end of a variable period; and the same lesions as we have described, will be observed on dissection.

234. Do not these experiments seem to prove, as M. Magendie has observed, that in those cases in which the emetic tartar produces death, this effect appears to be owing to the absorption of this salt, and its conveyance into the mass of the circulation, rather than to any direct action exerted upon the stomach itself?

235. M. Magendie wished to know, what was the influence exercised by the nerves of the eighth pair on the inflammation which takes place in the lungs, subsequent to the injection of a certain quantity of tartar emetic into the veins?

Experiment 1st. Twelve grains of tartar emetic injected into the jugular veins of several dogs, in which the nerves of the eighth pair were cut, did not produce death till after two hours; whereas animals in which this section has not been made, die in half an hour after the injection.

Experiment 2nd. The same dose injected into the jugular vein of several dogs in which the two *pneumo-gastric* nerves have been cut, does not produce death till after four hours.

Experiment 3rd. If three dogs about the same weight and age are taken, and twelve grains of tartar emetic injected into

the veins of each, it will be observed that the first who dies, will be the one on which the section of the eighth pair of nerves has not been made; the second will be that in which one of the *pneumo-gastric* nerves has been divided; and lastly, that in which both have been separated, will die the last. So that the life of an animal poisoned by a very strong dose of emetic tartar may be prolonged, by dividing the nerves of the eighth pair.

SYMPTOMS OF POISONING BY ANTIMONIATED TARTRATE OF POTASH.

236. Before describing the general symptoms of this species of poisoning, we shall relate some observations on certain individuals, in whom tartar emetic has produced alarming symptoms, followed sometimes by death.

OBSERVATION 1st.

" Claude Genaux des Villards, aged thirty years, of a hypochondriac temperament, subject for several years past to reiterated attacks of arthritic rheumatism, came to consult me in the beginning of May, 1808, for pains, or cramps, which he felt in the stomach, attended with loss of appetite, sometimes with vomitings, or a serous diarrhœa, which was alternated with an obstinate constipation. As his complexion had nothing of a leaden hue, nor any sensible fulness was to be discovered; and the patient did not begin to complain of these affections of the stomach till after the rheumatism had disappeared, and had even experienced a sensible relief once or twice on the return of slight pains of the joints; I concluded that this dyspepsia was occasioned by the rheumatic principle having fixed upon the stomach. I consequently prescribed leeches to the anus, warm baths, transitory blisters upon the

region of the stomach,* and upon the parts previously affected with rheumatism, and put him on the use of slightly diaphoretic drinks, and powders composed of the kermes and Extract. Aconit. Napell."

"The body of the patient was covered with flannel. These means, together with a nourishing diet, and abstinence from violent exercise, produced a sensible amelioration in his health at the return of fine weather."

"The 5th of June, 1809, I was called upon, conjointly with M. Bailly, to attend on the said Genaux, who, some days before complaining of pains in the stomach, had taken a very large dose of tartarized antimony, by the advice of an empiric. Dreadful vomitings very soon succeeded to the administration of the remedy; the pains at the stomach became more acute; and at the expiration of a few hours, the patient complained of a difficulty of swallowing: in a short time deglutition became impossible. The œsophagus was so hermetically closed, that the patient could not swallow the smallest drop of liquid of any kind. M. Bailly bled the patient, applied emollient fomentations to the belly, and afterwards a blister to the stomach. The difficulty of swallowing did not yield to these remedies; the spasm extended itself even to all the muscles of the neck, to such a degree, as to impede the circulation: the patient's face became red, his eyes injected, and on every attempt to raise his head, he experienced such vertigoes, as obliged him to replace it immediately on the pillow. This state of things had continued thirty-six hours when I arrived: I immediately ordered leeches to the neck, to disperse the local congestion. This bleeding produced the desired effect; the vertigoes ceased, the face became less red, and the patient was able to go into the warm bath, which induced a little relaxation. This man, who was very far from having any aver-

* The term *(vesicatoires volans)* is used to express a blister, which has been long enough applied to excite redness and inflammation; but which is removed previous to the detachment of the cuticle.—*Translator.*

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sion to liquids, but earnestly desired them, was not able to swallow a spoonful of the decoction of bark, which I had prepared in case he should have been poisoned by the tartarized antimony. He was more fortunate in taking into his mouth a tea-spoonful of a marmalade, made of the syrup of marshmallows, manna, gum-arabic, and oil of sweet almonds; this entered the stomach. Glysters of assafœtida, frictions with opium upon the region of the stomach and œsophagus, and transitory blisters, dispersed this spasm of the œsophagus at the end of twenty-four hours, which however made its appearance occasionally, on the following days.*

"I have already seen several cases of poisoning produced by very strong doses of tartarized antimony, since the exercise of our art has been shared by empirics of both sexes; and that the laws which prohibit the grocer-druggists from selling medicines, in Savoy, have been neglected. I saw amongst others, a few years since, a woman who had taken at least twenty grains of tartar emetic; beside dreadful pains and incessant vomitings, she experienced a spasmodic locking of the jaws, and convulsions. A very strong infusion of bark with opium, appeased the vomiting: she has ever since preserved a state of irritability of the stomach, which has never entirely ceased, and which could only be moderated by the habitual use of milk and mucilaginous substances."†

* I have had the opportunity of seeing a similar case. A child of ten years of age, to whom I had given a grain of tartar emetic, with the design of exciting vomiting, was attacked half an hour after with a great difficulty of swallowing, and severe pain in the throat. When I came to him, these symptoms had existed for two hours, and the patient had not had any vomiting: he did not then complain of any pain. The application of ten leeches to the lateral parts of the neck, calmed these symptoms in a very little time; but the patient could not be made to vomit but by administering twenty-four grains of ipecacuanha.

† Journal Général de Médecine, rédigé par M. Sedillet, Jan. 1811, page 58. Observation rapportée par M. Carron, medecin à Anneey.

OBSERVATION 2nd.

A Jew had bought an ounce of tartar emetic, instead of an ounce of soluble cream of tartar; he put part of this substance into a drink of wild endive, and took a glass of it in the morning fasting.

I calculated that the drink taken, contained about twenty grains of the antimoniated tartrate of potash.

A few moments after having swallowed it, pains began to be felt in the region of the stomach: they continued increasing, and even brought on syncopes: after this, came on excessive vomitings of bilious matter. When I arrived, the vomitings were succeeding one another with an alarming rapidity: the patient began to complain of abdominal colics; these soon after became violent; the stools were incessant; they consisted of an aqueous fluid, and were very abundant: the pulse was small and concentrated, the face pale: there was great prostration of strength: extremely painful cramps seized the legs at every instant, which was the symptom most complained of by the patient.

I ordered him a decoction of marshmallows for a drink, and emollient glysters. I had begun by making him take a few cups of decoction of bark, and two glysters made with the same substance; from time to time an opiate draught was administered: this last medicine appeared to be extremely serviceable to him. The irritation which this large dose of tartar emetic excited on the alimentary surface, produced a set of symptoms which I compared to a *Cholera morbus*. This state of disease lasted only five or six hours, at which time the symptoms subsided: in the evening the patient complained only of great debility. The following days he was tormented by painful digestions: these secondary symptoms yielded easily to the use of a slight infusion of Roman Chamomile and orange leaves, and to ten or twelve grains of theriaca taken before each meal.*

* An observation communicated by Dr. Barbier, of Amiens.

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OBSERVATION 3d.

M. N———, forty-three years of age, being resolved on destroying himself, asked for arsenic of several apothecaries, who refused it him: without changing his determination, he resolved on poisoning himself with tartar emetic. After he had collected about twenty-seven grains of it from different shops, he went into a coffee-house, and asked for a glass of sugared water; he dissolved this quantity of the tartar emetic in about a third of the liquor, which he drank.

He instantly went out of the coffee-house, but had hardly gone twenty steps, before he felt a burning pain in the epigastric region, accompanied with convulsive movements, and a loss of his senses: he was carried in this situation to the *Hotel Dieu*, ten minutes after the accident.

Being come a little to himself, he sent away the assistants, and confessed to the sister of the ward and to myself, that he had poisoned himself with tartar emetic. We immediately gave to him three pots of a strong decoction of bark, which he drank in about an hour and a half.

It should be observed, that at the moment of his arrival, the skin was cold and clammy from head to foot, the breathing a little short, the pulse small and concentrated, the epigastric region a little tumefied, and very painful: there was a hiccup tolerably frequent, but no vomiting.

The greatest part of these symptoms diminished in violence, as soon as he had taken the first glass of the decoction of bark; two hours afterwards he went copiously to stool; he had five evacuations in the space of three hours: he afterwards sweated profusely, and changed his linen two or three times.

He continued a weak decoction of bark during the night, united with mucilaginous substances: nevertheless, the next day he had several vomitings in the morning: a degree of *gastritis* succeeded, which lasted several days. A month after he still felt at longer and longer intervals, prickings in the region of the stomach.

This fact presents two remarkable circumstances:

1st. The absence of vomiting, after having taken so great a quantity of tartar emetic.

2nd. The kind of flux which made its appearance after the action of the bark: this effect very much resembles that produced by the *bolus ad quartanas*, which, as is well known, is a mixture of tartar emetic and bark. Could this combination have taken place in the stomach? — all the circumstances lead us to think so.*

OBSERVATION IV.

A man of about fifty years of age, of a strong constitution, had suffered some domestic troubles, and conceived the idea of poisoning himself: he procured forty grains of tartar emetic, and took them one Saturday morning in a small quantity of some vehicle: he was not long before he began to have vomitings, frequent stools, *(super-purgation)*, and convulsions. He was received into the Hotel Dieu on the Sunday evening.

On the Monday morning he complained of violent pains in the epigastrium, which was distended; he could with difficulty move his tongue; he was in fact, in such a state, that he might be taken for a drunken man; he just spoke; his pulse was imperceptible. During the day, his belly became inflated, the epigastrium was considerably tumefied, and became more painful: in the afternoon delirium came on. On Tuesday all the symptoms increased; in the evening furious delirium; convulsions supervened, and he died in the night.

Appearances on Dissection.

The limbs extremely stiff, and half bent; a viscous and

* Obs. communicated by Dr. Serres.—This observation appears to me to confirm the result of M. Magendie's experiments, reported in his first Memoir on Emetic Tartar.

white liquor flowing from the mouth when the body was moved. The head inclined to the left side.

Towards the anterior part of the hemisphere of the brain, on the same side, ossification of the *Dura Mater* in a circular form, of about an inch and a half in diameter; opacity, increased thickness of the arachnoid membrane; a uniform redness; recent inflammation of the portion of that membrane which covers the anterior lobes of the brain, more apparent on the right side. Anfractuosities filled with a serous liquor tinged red, and collected in still greater quantity in the basis of the cranium; cerebral substances softer than usual; the left ventricle contained four or five spoonsful of a serous fluid, transparent and colourless; the right contained less of the same liquid.*

Thorax sound.

The peritoneum presented generally a brick-coloured appearance: the stomach and intestines distended by gas.

The mucous membrane of the stomach sound in its greater extremity; but red, tumefied, and covered with a viscous coat, easy to remove, throughout the most part of it: that of the duodenum was in the same state; the other intestines did not present any alteration, they did not contain the smallest quantity of excrementitious matter.†

237. The general symptoms of poisoning by tartar emetic, may be reduced to the following: rough metallic taste, nausea, copious vomitings, frequent hiccup, cardialgia, burning heat in the epigastric region, pains of the stomach, abdominal colics, inflation, copious stools, syncopes; small concentrated

* This affection of the arachnoid membrane, which is evidently here the principal cause of death; can it be attributed to the action of the tartarized antimony?

† This observation, communicated by Dr. Recamier, is extracted, as well as the two preceding, from the Memoir on the antimoniated tartrate of potash, by M. Magendie.

and accelerated pulse, skin cold, sometimes intense heat, breathing difficult, vertigoes, loss of sense, convulsive movements, very painful cramps in the legs, prostration of strength, death.

Sometimes to these symptoms, is joined a great difficulty of swallowing; deglutition may be suspended for some time: the vomitings and alvine excretions do not always take place, which generally increase the violence of the other symptoms.

LESIONS OF TEXTURE PRODUCED BY THE TARTAR EMETIC.

238. The conclusions suggested by the experiments of M. Magendie on living animals, ought already to induce the presumption, that the lesions produced by the antimoniated tartrate of potash consist principally in the alterations of the lungs and stomach.

The dogs which died from the action of tartar emetic injected into the veins, or introduced into the stomach, exhibited after death an inflammation more or less extensive of the lungs, and mucous membrane of the digestive canal.

Hoffman relates, that a woman experienced the most grievous symptoms a short time after having taken tartar emetic, and that she died. On opening the body, a part of the stomach was found sphacelated; the spleen, the diaphragm, the lungs, and parts adjacent to the affected portion of the stomach were gangrenous.

M. J. Cloquet has communicated to me the following case.

Panseron, aged fifty years, on the 24th of February, 1813, had an attack of apoplexy, of which he died on the 1st of March. During the five days of his illness, about forty grains

* Friderici Hoffmanni opera omnia, tom. i. pars 11, cap. v. p. 219. Genevæ, 1761.

of tartar emetic were administered to him, without exciting either nausea or vomiting: he had only a few stools. On opening the body, they found the brain injected, and containing a great quantity of serous fluid. The *thalamus nervorum opticorum* on the right side, exhibited on its inferior part, an oblong body, the size of an olive, consisting of a clear greenish pulp, and appearing to be in a state of suppuration on its surface. The whole of this body was easily detached from the cerebral substance. It is evident that these lesions were the cause of death; but the alimentary canal presented likewise alterations which manifestly depended upon the action excited by the tartar emetic. The stomach was extremely red, inflamed, and filled with mucosities and bile. The inflammation appeared to be confined to the mucous membrane of this viscus, on which irregular spots were perceived, of a cherry red colour on a ground of reddish violet: it shewed no signs of ulceration. There were likewise a few of these spots at the end of the second and third curvatures of the duodenum. The small intestines, which were of a rose colour, did not appear very much inflamed; they contained some mucosities and bile. Towards the end of the jejunum a small white tubercle was observed, the size of a pea, filled with a whitish pus, situated between the serous and muscular membranes of that intestine. The cœcum exhibited three spots of a deep red colour; there were likewise several such in the colon, but they were of a less lively red; the rectum was sound. In the lungs were observed blackish spots, very irregular, which extended more or less deep into the parenchyma of this organ.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY EMETIC TARTAR.

239. If it be recollected, that in general the antimoniated

tartrate of potash does not produce any grievous symptoms, except when it is not expelled by vomiting (§ 230), it will be readily conceived why this salt is so seldom the object of investigation in medical jurisprudence. In fact, being endued with a high degree of emetic virtue, it is for the most part thrown up before it has been absorbed in sufficient quantity to exert its deleterious action on the pulmonary organs and stomach. Nevertheless, since death may happen to be occasioned by its use, we think it necessary to point out in detail, the steps which the person called on to decide, ought to follow in this species of poisoning.

FIRST CASE.

The Person is living: the rest of the Poison can be procured.

240. If the poison be in a solid state, and in powder, a little of it should be heated in an earthen crucible, and if the powder is observed to exhale the odour of vegetable substances when burnt; if it grows black, and afterwards resumes afresh its white colour; lastly, if it leaves in the crucible, metallic antimony (§ 176), it may be presumed that it is tartar emetic; and, in order to be certain of it, another portion of it should be dissolved in fifteen times its weight of boiling distilled water; the solution ought to redden the tincture of tournesol, and afford a reddish yellow precipitate with the hydro-sulphurets, a dirty white, with galls, and a white with sulphuric and nitric acids, and with lime-water (§ 213 *& seq.*). The calcination would be sufficient to decide, if we could be assured that the poison was without mixture. In fact, of all the powders furnished by the other preparations of antimony, there is only the tartar emetic which contains any vegetable substance, and consequently which presents during its decomposition by heat, the phenomena which we have just described.

241. If the suspected substance be in a fluid state, a drop of it should be let fall into each of the tests enumerated, and

if the precipitates obtained be of such a nature as to cause a suspicion of the presence of tartar emetic, the rest should be evaporated to dryness in a capsule of porcelain: the product should then be detached, and calcined, in a crucible, in order to obtain the metallic antimony. This revival will be effected in twelve or fifteen minutes, provided that the sides of the crucible are thin, and the heat sufficiently strong to raise the whole to redness.

SECOND CASE.

The Person is living: the whole of the Poison has been swallowed: the Matter vomited can be procured.

242. This case, much more common than the preceding, and in appearance very complicated, presents but little difficulty. In fact, without producing any sensible action on most alimentary substances, the tartar emetic undergoes scarcely any decomposition, and, being expelled quickly by the efforts of vomiting, it is most frequently found unaltered in the fluids vomited; so that it is sufficient to pass them through a piece of fine linen, and submit them to the trials we have just described (§ 240). If from the mixture of this salt with bile, wine, &c. some of the precipitates pointed out should appear under a colour little favourable to their discovery, we ought then to depend upon the test of calcination, and we may decide that poisoning has taken place from some antimonial preparation, if the metallic antimony be obtained. It is clear, that in this case we cannot decide that this preparation is the tartar emetic, for all other poisons of this species, mixed with animal fluids, and decomposed by heat, furnish the same products. We might, on a rigorous analysis, extract the tartaric acid; but it is useless to have recourse to an operation attended with great difficulties, where there is but a small quantity to act upon.

243. It may however happen, that all these attempts are fruitless. Some vegetable infusions or decoctions, administered

before or after the ingestion of the tartar emetic, may have decomposed it, and converted it into an insoluble body, which would be sought for in vain, except amongst the solid contents of the stomach. The decoction of bark, recommended as an antidote to this salt, ought necessarily to produce this effect. In this case the solid materials must be taken, dried in a capsule of porcelain, and calcined in a crucible, with an equal weight of black flux (a mixture of charcoal and sub-carbonate of potash :) a few minutes of a red heat are sufficient to furnish the metallic antimony; a certain sign of the presence of some antimonial preparation. It may be conceived, that by the means of potash and charcoal, the reduction ought to take place, in whatever state the antimony may chance to be.

THIRD CASE.

The Person is living: the whole of the Poison has been swallowed: the Matter vomited cannot be procured.

244. This case, the prognosis of which in general is unfavourable, can only be elucidated by a retrospective view of the past symptoms, and an examination into those still existing. Chemistry is here of no avail.

FOURTH CASE.

The Person is dead.

245. The nature of the symptoms experienced by the patient, the chemical analysis of the substances contained in the alimentary canal, and lastly, the lesions of texture of the different parts; such are the numerous means which the practitioner may avail himself of under these circumstances.

After having detached the digestive canal, the contents of the stomach, both liquid and solid, should be collected, and their analysis undertaken in the manner we have indicated § 242, when explaining the second case. The presence of the metallic antimony will suffice to determine that poisoning has

taken place, whatever may be the state of the mucous lining of the intestinal canal.

246. If in spite of all the essays we have indicated, the poisonous substance be not discovered, before deciding that no poisoning has taken place, all the circumstances proper to throw a light upon the case ought to be examined and compared. It may indeed be conceived, that the tartar emetic not producing death until after it has been absorbed, it is possible that the patient may have died after a small dose, and there is no more of it remaining in the digestive canal.

TREATMENT OF POISONING BY THE ANTIMONIATED TARTRATE OF POTASH.

247. In this species of poisoning, the practitioner ought to pay a particular attention to the action exerted by the tartar emetic upon the person who has swallowed it. If this salt has produced copious vomitings, a short time after being taken, if the patient does not complain of sharp pains, if he has no convulsive movements, warm water, taken in great quantity, will be sufficient to restore health. In fact, this fluid will induce vomiting, after having dissolved a portion of the emetic tartar contained in the stomach. This method is to be preferred to that in which neutralizing substances are employed, such as infusions of cinchona, galls, &c. Whatever may be the energy with which these vegetable drinks decompose the tartar emetic in the stomach, the advantages procured by them cannot counterbalance that of expelling at once from the stomach the deleterious substance.

248. If the person poisoned has had no vomitings, even after having swallowed thirty or forty grains of this salt, in this case recourse should be had immediately to titillation of the uvula, or of the throat, and lastly warm water should be given in great quantities. Oil, copiously administered, sometimes

favours vomiting, and may consequently be useful. If, notwithstanding the employment of these means, vomiting cannot be brought about within a very short space of time, the decoction of bark at the temperature of from 30 to 40° should be administered in great quantity without delay. This medicine, proposed by Berthollet has often been attended with advantage. We have already reported a case of poisoning in which this drink has been followed with complete success (Obs. iii. page 176). Luchtmans has succeeded in causing tartar emetic to be taken in very strong doses without the least inconvenience, when he combined it with a sufficient quantity of decoction of bark, to decompose it entirely. He has observed, that this decomposition is more complete when the yellow bark is employed in place of the red, the precipitate obtained with this species of cinchona containing much less of the antimony than that formed by the yellow bark.*

249. The decoction of tea, of galls, with the addition of a little milk, that of the woods, of astringent roots and barks, may be employed in case of a deficiency of cinchona.

250. The earths, alkalies, alkaline sulphurets, and sulphurated hydrogen, ought to be rejected, being medicines, which, in this case, are without efficacy, and increase the irritation produced by the poison.

251. Opium ought to be employed in excessive vomitings, especially in persons of a nervous temperament.

252. Leeches, and even general blood-letting, are of great service, where a constriction of the pharynx, or when any inflammation of the œsophagus, lungs, or stomach, has come on. These cases, generally serious, require the treatment of the *mucous* or *parenchymatous Phlegmasiæ*.

* Disputatio Chemico-medica inauguralis de Combinatione Corticis Peruviani cum Tartaro Emetico. Trajecti ad Rhenum, 1800, by Luchtmans.

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OF THE OXYDE OF ANTIMONY AND GLASS OF ANTIMONY.

253. The oxyde of antimony obtained by calcining metallic antimony; or by heating this metal with the nitric acid, is of a white colour, and easily revives when heated with charcoal in an earthen crucible; it is insoluble in nitric acid; when brought in contact with the muriatic acid, it dissolves and furnishes a muriate which gives a white precipitate to water, and a red one more or less deep to the hydro-sulphurets. These marks, which we have more fully detailed when speaking of metallic antimony (§ 208), are sufficient to distinguish this oxyde from all the bodies with which it appears to be confounded. Its poisonous properties are extremely powerful, since two or three grains are sufficient to produce death.

254. The glass of antimony is formed of antimony, oxygen, sulphur, and silex.* It is likewise known by the name of vitreous sulphurated oxyde of antimony. It is transparent, and of the colour of the hyacinth. When heated in a crucible, with its bulk of charcoal, it is de-oxydated, and furnishes metallic antimony.

255. When treated by the muriatic acid, at the temperature of from 50° to 60°, it dissolves entirely (unless it chance to contain a very great quantity of silex). The water is decomposed; the oxygen acts upon the glass of antimony, oxydates it still more, and renders the oxyde of antimony soluble in muriatic acid; the hydrogen seizes on a portion of the sulphur, and is disengaged in the form of sulphurated hydrogen gas. The solution, formed principally by the muriate of antimony, precipitates, by the addition of water a white submuriate; and of the hydro-sulphurets a hydro-sulphurated oxyde of antimony of an orange yellow, or red colour.

* The glass of antimony of commerce contains almost always iron and albumine.

256. The glass of antimony, in the dose of seven or eight grains, acts as a violent poison. "*Cognita nobis sunt aliquot exempla*, says Hoffman, *ubi vitrum antimonii in substantia propinatum, præsertim, cum jam prima regio spasmis obnoxia fuit, non secus ac Arsenicum intra aliquot horas mortem intulit, præcedentibus omnibus signis ac symptomatibus quæ propinatum venenum indicant et sequuntur.*"* This celebrated author mentions a case of a patient attacked with intermittent fever, to whom some glass of antimony was given a few moments before the accession of the paroxysm; copious vomitings, frequent stools, convulsions, a general trembling, and great anxiety, were the symptoms which made their appearance, and which subsided during the hot stage. The next day being tormented by a fresh paroxysm, the patient died, under the symptoms produced by the poison. On opening the body, the stomach was found inflamed and sphacelated.†

OF KERMES MINERAL, AND GOLDEN SULPHUR OF ANTIMONY.

257. Kermes, known also under the name of brown hydrosulphurated oxyde of antimony, is a compound of antimony, oxygen, hydrogen, and sulphur, in which the oxyde of antimony predominates. Its brown red colour is so much the deeper, *cæteris paribus*, as it is better preserved from the contact of light.

258. When mixed with an equal bulk of charcoal, and heated to redness in a crucible, it decomposes, and gives out metallic antimony, water, carbonic acid gas, and sulphureous acid gas.

* Friderici Hoff. Op. Omnia, pars ii. cap. ii. page 197, ann. 1761.

† Idem, pars ii. cap. v. page 213.

Rationale. By the action of caloric, a portion of oxygen and hydrogen unite and form water, which is disengaged; whilst at the same time the sulphur and charcoal lay hold on all the remaining oxygen, and give birth to the sulphureous and carbonic acid gases.

In order to obtain the metal by this process, the temperature must be raised very high, and the mixture exposed to it for a long time. But if, instead of operating upon a mixture of kermes and charcoal, kermes, charcoal, and dried potash be employed, the revival of the metal is more easily effected, and in a much shorter space of time.

259. Kermes is insoluble in water.

260. If it be boiled with a sufficient quantity of a solution of caustic potash, it is immediately decomposed, loses its colour, and is converted into an insoluble white oxyde of antimony; and into a fluid, which is nothing but the hydro-sulphuret of sulphurated potash, holding a little oxyde of antimony in solution.

Rationale. The potash lays hold of the hydrogen and the sulphur contained in the kermes, and passes into the state of a hydro-sulphuret of sulphurated potash, which possesses the property of dissolving a little of the oxyde of antimony: we may be assured that this fluid contains oxyde of antimony, by mixing it with a few drops of nitric acid. The nitric acid instantly combines with the potash, and a precipitate is perceived of a yellow colour, more or less inclining to red, which consists of oxyde of antimony, hydrogen, and sulphur.

261. The muriatic acid exerts a remarkable action on kermes. If a certain quantity of kermes be put into a bottle with a ground stopper, and the bottle be filled up with muriatic acid diluted with one third of its bulk of water, it will be seen that these two bodies will act one upon the other, that a portion of the kermes is dissolved, that the mixture acquires a yellow colour, and a small quantity of sulphurated hydrogen

gas is disengaged. If the bottle be stopped in order to prevent this escape of the gas, a yellowish white fluid is obtained, consisting of a very acid muriate of antimony, and a small quantity of sulphurated hydrogen. It is evident that the muriatic acid decomposes the kermes, and lays hold of the oxyde of antimony, with which it forms an acid muriate; whilst at the same time the hydrogen and the sulphur combine to form sulphurated hydrogen gas, which remains in the solution without precipitating the oxyde of antimony. This phenomenon depends upon the small quantity of sulphurated hydrogen formed, and above all on the great excess of muriatic acid with which the oxyde is combined.

If this solution of muriate of antimony and sulphurated hydrogen be decanted, and a few drops of water be poured into it, an *orange yellow* precipitate is obtained formed of hydrosulphurated oxyde of antimony. In this case the water lays hold of the excess of muriatic acid; the oxyde of antimony is consequently less tenaciously retained, and the sulphurated hydrogen precipitates it in the ordinary way. This fact is remarkable in that it furnishes the instance of a solution of the muriate of antimony, with which water throws down an orange-coloured precipitate, instead of a white one.

If this solution of muriate of antimony and sulphurated hydrogen be filtered, and boiled for a few instants, the sulphurated hydrogen is disengaged, and then the muriate of antimony resulting from it gives a *white* precipitate with water, which is perfectly agreeable to all we have laid down.

262. The golden sulphur of antimony, composed of oxygen, antimony, hydrogen, and sulphur, contains less of the oxyde of antimony, and more of the sulphur than the kermes: its colour is not so deep, and, on being heated with charcoal, it gives out metallic antimony. We will not delay any longer on the properties of this body, since it is very little employed in medicine.

263. These two preparations, especially the latter, are hurtful when incautiously administered. The golden sulphur of antimony has been known to produce copious vomitings, abundant stools, and inflammation of a portion of the digestive canal.

OF THE MURIATE AND SUB-MURIATE OF ANTIMONY.

264. The muriate of antimony may either be liquid, solid, or of the consistence of a thick oil; in this last case, it bears the name of *butter of antimony*.

265. When it is mixed with potash, and the mixture calcined with charcoal, there is obtained, muriate of potash, fixed metallic antimony, and carbonic acid gas. It is evident that the potash sets the oxyde of antimony at liberty, and the charcoal seizes on the oxygen which that contains, to form carbonic acid, whilst at the same time the metal is revived.

266. Water and sulphurated hydrogen decompose the muriate of antimony, as we have observed when speaking of metallic antimony (§ 208).

267. The sub-muriate of antimony is composed of oxyde of antimony and a little muriatic acid. It is known under the names of *powder of algaroth*, and *mercury of life;* its colour is white, slightly inclining to yellow. It can easily be proved, from the three following experiments, that this body contains muriatic acid.

1st. When it is heated in a close vessel, a small quantity of butter of antimony is obtained (volatile muriate of antimony) and an oxyde of this metal remains in the retort.

2nd. When made to boil with caustic alcoholized potash dissolved in distilled water, it gives a muriate of potash which is soluble, and an oxyde of antimony which is insoluble.

3rd. Lastly, when treated several times with pure nitric

acid, oxygenated muriatic acid is obtained, which flies off, and oxyde of antimony at maximum, which remains.

268. It will be always easy to distinguish this submuriate of antimony from other known substances, by the facility with which it will revive on being heated with charcoal and potash; by the change of colour that the hydro-sulphurets produce in it, which convert it into a hydro-sulphurated oxyde of antimony, more or less red; by its action upon pure potash, which it causes to pass in part into the state of muriate of potash; by its little solubility in water; lastly, by its solution in muriatic acid at the ordinary temperature, with which it forms a muriate, which furnishes a white precipitate to water, and an orange-red to the hydro-sulphurets.

269. Of all the antimonial preparations, there is none that possesses at the same time an emetic and drastic property to so high a degree as the salt we have just been tracing the characters of.

Olaus Borrichius relates, that a merchant of Copenhagen, who had suffered a long time pains from the gout, and a great weakness of the knees, put himself under the hands of a surgeon of a ship, who persuaded him that he could never be cured until he had undergone salivation. He consequently took, by the advice of this surgeon, a few rather strong doses of the *mercury of life* (sub-muriate of antimony), which purged him violently upwards and downwards, and which caused him afterwards so considerable a salivation, that he fell at length into such a state of exhaustion and weakness as can scarcely be imagined. Being called to him about the end of July, he found him cold as ice, although there was a large fire in the room; his pulse was not perceptible, and he breathed with great difficulty: he nevertheless enjoyed all his intellectual faculties. He died in the course of the night.*

* Acta Medica et Philosophica Hafniensia, ann. 1677, vol. v. Obs. lii. p. 141.

OF ANTIMONIATED WINE.

270. Antimoniated wine bears also the name of *emetic wine.* Its composition varies according to the mode of preparing it: it is commonly obtained by digesting, during ten or twelve days, four ounces of sulphurated semi-vitreous oxyde of antimony (glass of antimony) in two pints of Malaga wine, or any other white wine. The tartaric, malic, and acetic acids contained in the wine dissolve a certain portion of the oxyde of antimony, to which this medicine owes its principal virtue.

271. This antimoniated wine is of a yellow colour so much the deeper as it is more concentrated, to such a degree that it appears red when in a high state of concentration: its taste is sweetish, and slightly styptic. It is transparent; however, before being filtered, it is turbid; and in that state possesses much more energetic medicinal properties. Antimoniated wine strongly reddens the tincture of tournesol.

272. If it be put into a glass retort, to which a balloon has been fitted, and the retort be heated gradually, alcohol will be obtained in the recipient, and there remains a thick liquor, composed of the different fixed principles of the wine and antimonial salts. This liquor, being evaporated to dryness in a capsule of porcelain, and calcined in a crucible with charcoal, furnishes metallic antimony.

Rationale. The acetate, malate, and tartrate of antimony, as well as the acidulated tartrate of potash of the wine, are decomposed by the action of heat; the acids which enter into the composition of these salts, are converted into several volatile productions, and a certain quantity of charcoal: this combustible body acts upon the oxyde of antimony which results from the decomposition of these antimonial salts, carries off its oxygen, passes into the state of carbonic acid, and the metallic antimony is set at liberty.

273. Antimoniated wine is not precipitated by water.

274. If one or two drops of a hydro-sulphuret be poured into a great quantity of emetic wine, a precipitate will be obtained of a deep red, consisting of oxygen, hydrogen, antimony, and sulphur. If, on the contrary, a great quantity of the hydro-sulphuret be employed, the precipitate will be black.

275. The sulphuric acid precipitates it immediately; the sediment is of a deep yellow colour, slightly bordering on gray.

276. The infusion of galls in alcohol acts with this liquor as with the solution of tartar emetic. It precipitates it of a dirty white colour.

277. These characters are sufficient to distinguish the antimoniated wine, from all other medicinal preparations. It sometimes happens, that emetic wine submitted to analysis, may act a little differently with the tests we have mentioned; this effect depends on the nature of the wine which enters into its composition, on the quantity of oxyde of antimony it holds in solution, and on the manner in which it has been prepared. In this case recourse must be had to the two distinguishing characters we have pointed out, and which are always constant: 1st. the possibility of obtaining alcohol from it by distillation: 2nd. the separation of the metallic antimony by calcination.

278. If the emetic wine has been prepared by dissolving tartar emetic in white wine, its properties will differ a little from those we have been speaking of; but it will always be easy to recognise it by paying attention to all that has been said before, and to the properties of stibiated tartar (§ 210, *& seq.*).

279. The antimoniated wine possesses the most energetic deleterious properties: for which reason it is only employed in medicine in the form of glysters, in doses from two drachms to four ounces.* We shall report two cases of poisoning

* M. Orfila must here confine his ideas to the present practice of the

by this fluid, mixed with a certain quantity of glass of antimony.

OBSERVATION 1st.

Manget relates, that a woman digested a few grains of glass of antimony in some white wine, for about an hour; and the next morning she swallowed the fluid, together with the portion of glass of antimony, which remained undissolved. The poison did not at first produce any bad symptoms; but it gave rise in the end to copious vomitings, and so violent, that not being able longer to support herself, she fell to the ground. In this situation she was found by her husband, with the limbs cold and stiff, as if dead; he employed various exciting methods to restore her, and at last succeeded in bringing back respiration, by throwing cold water in her face. When she had recovered the use of her senses, she did not cease, however, from vomiting, and was agitated by convulsive motions, until a copious drinking of broth had overcome the violent action of this poison; but she remained very weak for a long time.

When she began to recover her strength, she was attacked with a very sharp pain in the right foot; the next day it was affected with gangrene, and the limb was amputated about six inches below the knee. She was nearly recovered from the consequences of the amputation, when, at the distance of seventeen days from the poisoning, a suffocating catarrh made its appearance, of which she died shortly after.*

French capital. It was certainly employed by the ancient French physicians, as it is now by our own, both as an emetic and as a diaphoretic, in small doses.—*Translator.*

* Manget Biblioth. Med. tom. iv. lib. xviii. p. 449. Genevæ, 1639.

Without pretending to account for the gangrene of the right foot, which might perhaps be attributed to the icy coldness of the extremities, we are of opinion that the thoracic affection might be the result of the irritation

On opening the body, the lungs were found closely adhering to the pleura, principally on the right side; they were spotted; the bronchia were filled, throughout their whole extent, with a frothy mucus. The cavities of the chest contained a great quantity of water in those parts where the lungs were at liberty. The heart exhibited polypous concretions. The stomach was distended. The liver, which was of a yellow colour, a little variegated, was adhering to the diaphragm in several places. The spleen was of a greater bulk than ordinary.

OBSERVATION 2nd.

Fabricius de Hilden relates, that a woman, who was complaining of pains in the stomach, took at two different times, by order of a physician, a draught, which was nothing else but wine into which glass of antimony had been put. The first dose brought on very copious and repeated vomitings, which became still more considerable, when she had swallowed the second portion. The patient became deaf of the right ear.*

OF THE OTHER PREPARATIONS OF ANTIMONY.

280. The diaphoretic antimony, washed, and not washed (oxyde of antimony combined with potash), the *materia perlata* of Kerkringius (oxyde of antimony, at maximum), the liver of antimony (a mixture of oxyde of antimony, sulphur,

produced in the lungs by the antimonial preparation; at least this opinion seems to us extremely probable, according to the numerous and correct facts reported by M. Magendie, in his first memoir on the antimoniated tartrate of potash.

* Fabricii Hildani, Op. Cit. Cent. V. obs. xii. page 233. Lugduni, 1641.

and sulphate of potash), the *Crocus* Metallorum (sulphurated oxyde of antimony), &c., are so many poisonous preparations.

281. Metallic antimony may be extracted from them by mixing them with charcoal, and heating them to redness in an earthen crucible. The presence of this metal, which is easy to ascertain by pursuing the methods laid down, § 206 and 208, is of itself sufficient to decide in a case of poisoning. We shall not enlarge any more upon these preparations, which are at this day banished from the Materia Medica, and which rarely form the subject of medico-juridical investigation.

OF ANTIMONIAL VAPOURS.

282. Persons subjected to the action of antimonial vapours experience a great difficulty of breathing, a tightness of the chest accompanied by a cough more or less dry, which often is the forerunner of an hæmoptysis; they are subject to gripings and looseness. Fourcroy relates, that he has seen fifty persons, in whom all these symptoms made their appearance ten or twelve hours after having respired the vapours of sulphuret of antimony, which had been detonated with nitre. There is not the least doubt that the prolonged action of these vapours is capable of giving rise to serious accidents, followed by death.

ARTICLE IV.

SPECIES IV.—POISONS OF COPPER.

Var. 1st. Brown Oxyde of Copper.
—— 2nd. Verdegris.
—— 3rd. Acetate of Copper, Crystals of Venus.
—— 4th. Sulphate of Copper.

Var. 5th. Sulphate of Ammoniacal Copper.
—— 6th. Nitrate of Copper.
—— 7th. Muriate of Copper.
—— 8th. Ammoniacal Copper.
—— 9th. Coppery wine and vinegar.
—— 10th. Coppery *Savonnules*, or copper dissolved by grease.

283. It may be asserted that the case of poisoning by the preparations of copper, is one of the most common; and the most important to be acquainted with: for which reason we see that the attention of physicians and chemists, has at all times been directed towards the knowledge of those means, which are capable of bringing to perfection the history of all the objects connected with it. The daily use of utensils of copper, the facility with which it combines with oxygen, the deleterious action which this oxyde exerts upon the animal economy, are so many causes, which account for the frequency of this kind of poisoning, and justify the importance which learned men have attached to the study of these poisonous substances. Rarely, indeed, have the preparations of copper been employed as the instruments of crime, as their fatal intentions would have been detected by the colours which they present; but how many times, by the inadvertence, I might even say, by the inexcusable negligence, of persons who make use of vessels formed of this metal, which have been not at all, or very badly, tinned, have they been productive of accidents, so much the more terrible, as they have exerted their action on a great number of persons at once? The annals of medicine unfortunately furnish too many examples in support of this assertion, to render it necessary to insist more upon it here.

After taking this hasty sketch of the subject, we shall now proceed to detail the various properties of the preparations of copper, beginning with the history of metallic copper, without which we shall not be able to fix the characters of

the poisonous substances which form the object of this article.

OF COPPER.

284. Copper is a metal of a beautiful yellowish red colour. Although it is brilliant, malleable, and ductile, it only possesses those properties in an inferior degree to the more precious metals. Being endued with a strength of adhesion less than that of iron, it is more sonorous than it, or than all the other metallic substances. Its specific gravity is 8,895 when melted.

285. Copper is fusible only at a very high temperature; it is not volatile.

286. This metal is capable of being combined with two different proportions of oxygen; the oxyde at minimum of an orange yellow, containing about eleven parts of oxygen in a hundred; the other, consisting of eighty parts of copper and twenty of oxygen: it is of a blackish brown colour when calcined. These oxydes, heated in an earthen crucible with their bulk of charcoal, or of some fat substance, lose their oxygen, are revived, and give out carbonic acid gas, which escapes.

287. Copper exposed to a moist atmosphere, becomes tarnished, absorbs a portion of its oxygen, and passes into the state of an oxyde, which soon after unites with the carbonic acid of the atmosphere, to form a greenish carbonate of copper.

Copper combines with sulphur, and forms a black sulphuret.

288. Copper dissolves in the principal mineral acids, provided that their temperature be raised to the point of ebullition. The solutions which it furnishes exhibit in general a blue, or green colour. This is one of the characters from which the juridical physician may derive advantage.

289. The sulphate of copper obtained by boiling copper

filings, or, what is better still, the oxyde of this metal in the sulphuric acid, is of a beautiful blue colour.

290. The nitric acid at 25°, poured cold upon copper shavings, instantly undergoes a remarkable decomposition; the liquor becomes green: the vessel in which the experiment is made, is filled with red vapours formed by the nitrous acid gas; lastly, the copper disappears, and when the reciprocal action of these two bodies is at an end, the solution passes to a blue colour, and contains only nitrate of copper.

Rationale. The oxygen and azote which enter into the composition of the nitric acid, have very little affinity between them, whilst at the same time the copper exerts on the former of these principles a very strong action. Consequently this metal seizes on a portion of the oxygen of the nitric acid, passes into the state of an oxyde, and is dissolved in the remaining acid not decomposed. The azote retaining a portion of oxygen, is partly disengaged in the state of nitrous gas, which is converted into red nitrous acid gas, by means of the oxygen contained in the air of the vessel in which the experiment is made. Another portion of the nitrous gas remains in the solution, to which it imparts the greenish colour, of which we have spoken,* and which disappears in proportion as the gas becomes disengaged. The decomposition of the nitric acid in this operation is favored by the tendency which the oxyde of azote has to become gaseous.

If, instead of causing the copper and nitric acid at 25°, to act on each other at the ordinary temperature, a very concentrated acid be employed, and boiling, the action is much more brisk, and the decomposition of this acid is much more complete.

291. The muriatic acid is capable of forming with the

* Nitrous gas, combined in a certain proportion with nitric acid, or with the acid metallic nitrates, gives them a green colour. This effect depends on the nitrous gas converting part of the nitric acid into green nitrous acid.

CEYLON

oxydes of copper, salts of a different nature. The muriate at minimum, of a white colour, is decomposed by potash, which separates from it the orange yellow oxyde: the muriate at maximum, which is of a green colour, is precipitated of a blue, by the alkalies.

292. The acetic acid, and vinegar, dissolve easily the oxyde of copper; the salt resulting from it is of a blue colour inclining to green: it bears the name of *Crystals of Venus*, and forms part of verdegris.

293. Ammonia likewise dissolves the oxyde of copper, and the solution presents a beautiful blue colour, known by the name of ammoniacal copper (*eau celeste*). If instead of employing the copper oxydated, metallic copper be used, the solution is not long in taking place, although in a manner less sensible. The experiment may be made, by putting some copper turnings into the bottom of a ground-stopper bottle, which should be filled with ammonia, and the bottle stopped in order to preserve the metal from the contact of the air. The fluid, which floats on the copper, remains colourless, and preserves its transparency: but if the stopper be removed after a few hours, and the ammonia be decanted, it will instantly be perceived that this alkali becomes blue by the contact of the air; which could not take place unless it held copper in solution.

294. Metallic copper perfectly pure does not possess any deleterious property. *Thomas Bartholin*, *Amatus Lusitanus*, *Lamotte*, *Hevin*, &c. relate cases of persons who have swallowed pieces of copper without experiencing the smallest inconvenience. These extraneous bodies have been expelled either by vomiting or by stools at the end of a space of time which is variable. Professor Dubois saw a young child that had swallowed a copper buckle for some time. It suffered no pain; its excrements only were greenish, and resembled in colour the *baume tranquille*. Analysis proved, that there was not an atom of the metal of which the presence was suspected.

The buckle covered over with a slight oxyde of a brown colour, was expelled five or six weeks after having been swallowed.*

These facts are sufficient to prove the innocence of metallic copper in masses; but is the case the same when this substance is extremely divided? The results of the experiments made by M. Drouard prove, that there is no danger in swallowing this metal pure, whatever may be its state of division. This physician has given as much as an ounce of it, in a very fine powder, to a dozen of dogs, of different ages and different sizes, and none of them experienced any inconvenience. The next day, the metallic molecules, which were tarnished, were expelled with their excrements.

295. Desirous of ascertaining to what degree oil and fat bodies, which dissolve so easily the oxyde of copper, would act on this metal in the stomach, M. Drouard made the following experiments.

1st. Half an ounce of copper filings, mixed at the same moment with eight ounces of grease, was given to a great dog, who felt no bad effect from them.

2nd. The same dose of filings was given to a dog of middle size; four ounces of oil were injected into the stomach, and he was opened five hours afterwards. The metal had preserved its metallic brilliancy, and a part of it was in the stomach, the rest in the intestinal canal. The copper filings, the oil, and the gastric liquors contained in the stomach were put into a vessel. All the metallic particles subsided to the bottom; the oil, which floated on the top, became of a green colour; and the gastric fluids, being secured by the oil from the contact of the air, did not, at the expiration of a month, exhibit any sign of putrefaction, and had not dissolved any part of the copper.

* Experiences et Observations sur l'Empoisonnement par l'Oxyde de Cuivre (Vert-de-gris); Dissertation soutenue à l'Ecole de Médecine de Paris, an 1802, par Claude René Drouard, page 8.

M. Drouard concludes from these experiments, that oil does not dissolve copper in the digestive organs. The same thing takes place with vinegar, which is made to act in the stomach upon this metal in a very pure state.

296. M. Portal relates a case, which does not seem, at first sight to agree with the experiments we have just quoted. "Some students in medicine had conceived the idea of treating a case of ascites with copper filings incorporated with crumbs of bread. They first gave only half a grain, which produced no sensible effect: they increased the dose by degrees, and carried it as far as four grains a day. The urine became extremely copious; the swelling was sensibly diminished, and every thing announced an approaching convalescence, when the patient began to complain of tenesmus; vomitings supervened; he experienced excruciating colics; his pulse was small and concentrated when I was called in. I caused him to drink abundance of milk, prescribed bleeding, and kept him in the warm bath several hours together at several different times. The symptoms subsided; and by the use of asses' milk, which was continued a long time, the patient recovered his health and lustiness."*

This case is not sufficient to annul what we have advanced relative to the innocence of metallic copper. It is probable, as M. Drouard likewise observes, that the copper filings, enveloped in the crumbs of bread, might have been prepared some time previous to their administration, and have become oxydated.

297. It has been long maintained, that milk heated, or allowed to remain in vessels of copper not oxydated, dissolved a portion of this metal, and acted as a poison. Eller, a philosopher of Berlin, has proved that this idea is not correct. He boiled in succession, in a kettle well freed from verdegris,

* Observations on the Effect of Mephitic Vapours on Mankind, by M. Portal, sixth edition, p. 437.

milk, tea, coffee, beer, and rain water: after two hours boiling, he found it impossible to discover, in any of these fluids, the least vestige of copper. M. Drouard has seen likewise, that distilled water left for a month together on the filings of this metal in a glass bottle, did not dissolve an atom of it.

298. The phenomena are different, if instead of pure water we substitute that which contains a certain quantity of muriate of soda. Eller has demonstrated the presence of a very small quantity of copper in water, which contained $\frac{1}{20}$th of its weight of muriate of soda, and which had been boiled in a brass kettle.* The quantity of copper dissolved has been found to be greater, when the saline solution is boiled in a copper saucepan well freed from verdegris. In fact, from the evaporation of this solution, a powder has been obtained which furnished twenty-four grains of acetate of copper on being dissolved in vinegar. It is easy to perceive how much these results are capable of giving information to the physician in certain cases of poisoning by aliments which are seasoned and heated in vessels of copper.

299. If instead of heating in copper kettles a simple solution of muriate of soda, it be previously mixed with beef, bacon, and fish, the fluid resulting from it does not contain an atom of copper. However astonishing this fact may appear, it is correct; M. Eller was the first to announce it, and I have several times ascertained its truth. It is probable that the combination of several other kinds of aliments destroys the effect of the solution of muriate of soda; which consequently ought to render the cases of poisoning by food cooked in copper vessels, which are not oxydated, extremely rare.

* In this experiment, the Berlin Philosopher employed five pounds of water and four ounces of the salt.

OF THE OXYDE OF COPPER, AND CARBONATE OF COPPER.

300. The oxyde of copper, which is of a blackish brown colour, may be easily known, 1st. by the facility with which charcoal and fat bodies de-oxydize it at an elevated temperature (§ 286); 2nd. by its solubility, without effervescence, in the sulphuric acid, weak, and at the ordinary temperature; 3d. by the properties of the solution resulting from it (see hereafter *Sulphate of Copper*); 4th. by the change of colour which it produces in ammonia; this alkali will dissolve it instantly, and assume a beautiful blue colour; 5th. lastly, by its insolubility in water.

301. The green carbonate of copper (natural verdegris,) spontaneously formed on the surface of copper or brass vessels, pieces of coin, &c. when treated with charcoal, ammonia, and water,* acts in the same manner as the oxyde of which we have just been speaking; but it differs from it by its green colour, and by its effervescence when dissolved in diluted sulphuric acid; which evidently depends upon the liberation of the carbonic acid gas, which enters into its composition.

302. The oxyde and carbonate of Copper are poisonous.

M. Drouard gave to a small dog four pieces of oxydated copper. A quarter of an hour afterwards the animal vomited a little bile. At the end of eight days he had not yet passed them, and had experienced no fresh inconvenience: two others were then given him, and three hours afterwards he was opened. The six pieces were found in the stomach; the two last exhibited an extremely brilliant surface, the other four were blacker than when the animal swallowed them.

* It is well known that water, which is kept in copper cisterns, remains without any alteration; and does not furnish, on analysis, the least trace of that metal, even when the surface of the cistern is coated with oxyde and carbonate of copper. This fact depends evidently on the insolubility of these two substances.

M. Drouard is of opinion that the gastric juices dissolve the oxyde of copper, and give a polish to the surface of the pieces; but that the sulphurated hydrogen, which is disengaged in the stomach, or in the intestines, brings back the brown colour, and converts it into a sulphuret.

303. It is known, that many persons have experienced colics and vomitings, in consequence of having swallowed pieces of copper that were oxydated.

304. The oxyde and carbonate of copper, which are frequently found on the surface of cisterns made of this metal, dissolve easily by the assistance of heat in several acid substances; such as certain aliments, the juice of sorrel, preserved apples, quinces, gooseberries, &c. Whence it follows, that all preparations of this kind made in vessels of copper that have undergone these changes, contain a greater or less quantity of coppery salts, which are capable of occasioning serious accidents. The following experiment comes in to the support of this assertion.

If an ounce of distilled vinegar, says M. Proust, be poured into a copper saucepan not tinned, and after having wetted the whole internal surface of the vessel with this acid, the liquor be left a few minutes at rest before decanting it, it will be found, on trying it with chemical agents, that it contains copper in solution; and that the quantity of this metal will be greater in proportion to the length of time that the vinegar has been left in the saucepan. It is easy to conceive, that in this experiment the different parts of the copper that have been wetted by the vinegar, ought to have been soon converted into an oxyde, because the oxygen of the atmospheric air has acted upon the metal.*

305. It sometimes happens that these acid preparations, when heated in copper vessels which are perfectly clean, dis-

* Annales de Chimie, tom. 57, supplement au Traité de l'Etamage, par Proust, p. 80.

solve a portion of this metal. This phenomenon only happens in those cases where the aliments cool, and remain a sufficiently long time in these kind of vessels, for the copper to pass into the state of an oxyde, at the expense of the oxygen of the air. M. Proust ascertained to a certainty, that none of these substances, when poured out immediately after being heated in clean copper vessels, did contain the least vestige of this metal.

306. Fat bodies, such as fixed oils, essential oils, &c. dissolve easily the oxyde and carbonate of copper; and when they are boiled in vessels of this metal perfectly clean, they facilitate their oxydation, especially if left to cool a few minutes before they are poured out.

307. Eller has proved that wine dissolves copper, and he obtained twenty-one grains of acetate of copper, after boiling in a vessel of this metal, five pints of white French wine. This phenomenon depends upon the acetic acid contained in the wine, and the oxydation of the metal by the air: whence it follows, that vessels coated with the oxyde and carbonate of copper, ought to furnish a much greater quantity of the acetate, the poisonous action of which is extremely energetic; and that consequently, it is very imprudent to leave the different kinds of wine in reservoirs of copper tarnished by the oxyde.

308. It is likewise to the formation of the oxyde of copper, and to the acetic acid contained in the wine, vinegar, beer, and cider, that the production of the acetate which forms about the corners of the cocks in vessels containing these liquors is to be attributed. M. Drouard was tormented for three days, with colic and diarrhœa, in consequence of eating a ragout, which had been seasoned with wine drawn out of a cask, the cock of which contained acetate of copper, which this liquor had in part dissolved.

M. Dupuytren has observed, that the vinegar in the small casks of the dealers who sell it about the streets, contained cop-

per; which explains clearly another fact related by the same learned professor, namely; that several persons were attacked with vomitings and gripings, in consequence of eating salads seasoned with this kind of vinegar. The solution of the copper in this case likewise depends upon the oxydation of the cocks with which these casks are furnished.

309. It will not appear a matter of surprize, after what we have just stated, that some persons should have died after taking medicines of the mildest and gentlest kind which had been prepared, and left for some time in vessels of copper. Acids and fat substances which frequently form a part of medicinal preparations, ought necessarily to favour the oxydation and solution of this metal.

CHEMICAL HISTORY OF VERDEGRIS.

310. Verdegris is formed of the acetate and sub-acetate of copper, of carbonate of copper, and copper partly in a metallic state, and partly in the state of an oxyde. It contains likewise the stalks of grapes and other extraneous bodies. The analysis of it may be made, 1st. by treating it with boiling distilled water, which dissolves all the acetate of copper;* 2nd. by pouring on the mass exhausted by the water diluted sulphuric acid at the ordinary temperature. This acid dissolves all the oxyde and the carbonate of copper, and carbonic acid gas is disengaged, which may be collected; 3d. lastly, by adding

* The sub-acetate of copper is decomposed in this operation; the boiling water transforms it into a soluble acid acetate, and into an oxyde of copper, which is precipitated. The presence of this sub-acetate, however, in verdegris, may be demonstrated by treating this substance with cold water: the whole of the acetate is dissolved, whilst the sub-acetate remains suspended, in the form of a fine powder extremely green. This powder, when dry, gives on distillation, radical vinegar; when brought in contact with the sulphuric acid, it diffuses vapours of vinegar.—*Proust, Annales de Chimie*, tom. xxxii. p. 39.

to the residue weak nitric acid, which dissolves only the metallic copper.

Verdegris is generally found in commerce in the form of masses of a bluish green colour, composed of a multitude of minute crystals which are silvery, and fine, like silk.

311. When verdegris, after being powdered, is submitted to the action of caloric in a small glass tube, it gives out metallic copper fixed, and all the productions furnished by vegetable substances, when submitted to the action of heat.

Rationale. The stalks, the seeds, and the acetic acid which form part of this substance, are decomposed by the action of caloric: there result from this decomposition several liquid and gaseous productions which are disengaged, and charcoal, which carries off the oxygen from the oxyde of copper, in order to form carbonic acid: the metal is consequently liberated.

312. The sulphuric acid of commerce, poured on verdegris in powder, decomposes it with effervescence, and vapours of acetic acid *(vinegar)* are disengaged, which may be known by their smell.

313. Verdegris when treated by boiling water, is only dissolved in part. The solution contains acetate of copper, whilst the residue, which is of a brown colour, more or less dark, contains the other principles of this compound.

314. This solution reddens the paper and infusion of tournesol; it possesses a strong styptic flavour, and is of a greenish blue colour. On evaporating it, rhomboids, or obtruncated tetraedral pyramids are obtained.

315. The sulphurated hydrogen gas decomposes it, and precipitates from it a black sulphuret of copper.

Rationale. The oxyde of copper contained in the acetate, yields its oxygen to the hydrogen of the sulphurated hydrogen gas, whilst at the same time the sulphur unites with the copper, with which it forms a sulphuret. This decomposition may

likewise be effected by the hydro-sulphurated water, the hydro-sulphurets, and hydrogenated sulphurets.

316. A small cylinder of phosphorus, being put into this solution, becomes covered, in the course of a few minutes, with a coat of metallic copper; and if a sufficient quantity of phosphorus be employed, the liquor loses its colour.

Rationale. This combustible body, which has a great avidity for oxygen, seizes on that which is contained in the oxyde in the solution, passes into the state of phosphoric and phosphorous acids, which are colourless; the metallic copper being no longer capable of uniting with the acetic acid, is precipitated in a state of extreme division, and is moulded on the little cylinder of phosphorus.

317. If a plate of iron perfectly freed from impurities, be substituted for this body, it will be seen, that this metal, in the course of a few hours, becomes covered with a portion of copper, and that the blue colour of the solution grows first green, and then passes to red.

Iron, being endued with a greater affinity for oxygen, and for acetic acid than copper, begins by precipitating a portion of this metal, and is converted into an acetate of iron of a reddish yellow colour, which appears green by its mixture with the portion of acetate of copper not decomposed, which is blue. The action of the iron on the solution soon after ceases, because it becomes surrounded on all sides with a coat formed by the precipitated copper. The decomposition however of the acetate of copper continues, which cannot be explained without admitting a galvanic effect similar to that we have noticed in giving the history of corrosive sublimate (§ 44). The water of the solution, being decomposed by the electric fluid disengaged by the contact of the copper with the iron, furnishes the hydrogen, which completely deoxydates the oxyde of copper, and there remains in the liquor only the acetate of iron of a reddish yellow colour.

318. Caustic potash, employed in small quantity, precipitates the solution of verdegris of a sky-blue colour, which becomes of a deeper blue, bordering on green, by the addition of a greater quantity of alkali. The precipitate is an oxyde of copper retaining a portion of the water. When dried on a filter, it is of a greenish colour, and if heated, it acquires the blackish brown colour peculiar to the dry peroxyde of copper (oxyde of copper at maximum). If in this state it be mixed with powdered charcoal, and submitted to the action of heat in a small crucible, which is made red hot, it becomes reduced, and gives out metallic copper diffused amongst the excess of charcoal; the metal can be easily perceived by putting the product of the calcination into water. The reduction of this oxyde depends upon the great strength of affinity which takes place between the charcoal and oxygen, when submitted to the action of an elevated temperature.

319. The sub-carbonate of potash (salt of tartar) likewise precipitates this solution of a sky-blue colour.

320. Ammonia at first separates the oxyde of a blue colour more or less deep; but if an excess of the alkali be added, the precipitate is redissolved, and the liquor, which consists of acetate of ammoniacal copper, is of an extremely beautiful blue colour. The sensibility of this re-agent is such, that a few drops of it are sufficient to discover the acetate of copper, in a solution which contains only a few atoms of it. This acetate of ammoniacal copper is of a blue colour; it is extremely deliquescent.

321. The water of barytes likewise decomposes the solution of verdegris: it forms with it a blue precipitate of oxyde of copper entirely soluble in pure nitric acid. The liquor contains acetate of barytes.

322. Arsenious acid in solution instantly precipitates the acetate of copper. The precipitate, which is very abundant,

and of a green colour, is the arsenite of copper, as we have observed under the article of *Arsenious Acid*, § 125.

323. The chromate of potash converts this salt into an insoluble chromate of copper, of a beautiful yellow colour, and into a soluble acetate of potash. The explanation of this phenomenon belongs to the law laid down in page 23, Note §.

324. The prussiate of potash in solution (triple prussiate of potash and iron) gives a brown precipitate with the solution of verdegris. The precipitate is formed of prussiate of copper, and prussiate of iron; the liquor contains acetate of potash.

Rationale. The solution of the triple prussiate of potash employed, consists of simple prussiate of potash, and prussiate of iron. This last, insoluble of itself, is dissolved by the former. It is clear then, that in proportion as the acetate of copper shall convert the simple prussiate of potash into an insoluble prussiate of copper, the prussiate of iron must be precipitated, having no longer any solvent, so that the precipitate ought to contain this prussiate, beside that of copper.

This triple prussiate of potash in a very diluted solution, being poured into acetate of copper dissolved in a very great quantity of water, gives instantly a red colour to the mixture, without producing the least turbidness: but at the end of twenty or five and twenty minutes, the same brown precipitate as we have just spoken of is thrown down. This test is one of the most sensible for discovering the smallest particle of acetate of copper.

325. The infusion of tea decomposes the solution of acetate of copper: a flaky precipitate is formed, of a reddish yellow colour.

326. If one part of a concentrated solution of verdegris be added to ten parts of red wine, the liquor preserves its transparency. It yields a black precipitate with the hydro-sulphurets, a brown with prussiate of potash, and a very dark gray

with ammonia. This last precipitate does not dissolve altogether in an excess of the alkali, and the fluid which floats above is never blue. Seven parts of the solution of verdegris and ten of wine furnish a fluid with which the agents above enumerated furnish analogous precipitates, except that the one furnished by the ammonia is of a black colour. From which we must conclude, that this alkali cannot be of any use in detecting the presence of verdegris if mixed with wine.

327. If albumine be poured upon the acetate of copper, a bluish coloured precipitate will be obtained: this precipitate, which consists of animal matter and a little oxyde of copper, when washed and placed on a filter, affords by calcination, metallic copper mixed with charcoal, and all the products usually furnished by animal substances when submitted to the action of caloric; it is evident that the oxyde is revived by the charcoal proceeding from the decomposition of the albumine.

328. Gelatine in solution, whether diluted or concentrated, produces no disturbance in the solution of the acetate of copper, whatever may be the temperature of the mixture; and the different tests of which we have hitherto spoken, precipitate this acetate just in the same manner as if it were alone, provided they be employed in sufficient quantity.

329. Broth brought in contact with this solution furnishes no precipitate.

330. Milk is coagulated by a great quantity of the solution of verdegris; the coagulum, when properly washed, is of a deep green colour; when dried and heated in a crucible, it undergoes decomposition in the manner of animal substances, and leaves for a residue charcoal mixed with metallic copper.

ACTION OF VERDEGRIS ON THE ANIMAL ECONOMY.

331. Almost the whole of the animals to whom a few

grains of verdegris have been given, died in a very short space of time. What is the cause of this death? On what organs does this poison exert its deleterious action?

M. Drouard is of opinion, that this poisonous substance acts immediately on the digestive canal, principally on the intestinal tube, in which it excites inflammation, without being taken up into the circulation, by the lymphatic vessels. The facts on which he founds this opinion, are as follows.

Experiment. M. Drouard gave to a tolerably strong formed dog fasting, twelve grains of verdegris alone. Mucous and bloody stools mixed with a great many worms, a disgust of all food and drink, fruitless attempts to vomit, were the first symptoms occasioned by the poison. The animal, not being able to support itself upon its legs, lay down upon its side, and expired twenty-two hours after the poisoning. The stomach contained a bloody fluid of a black colour; it was inflamed, particularly near its great curvature; and exhibited a blackish spot, which might have been taken for an erosion. The small intestines shewed no signs of inflammation: they were only filled with a greenish bile. There were in the rectum small ecchymoses similar to those in the stomach.

Experiment. Fifteen grains of verdegris mixed with aliments were given to a dog: half an hour after the animal made vain efforts to vomit; but he evacuated a great deal during the remainder of the day and night; his excrements were blackish, and mixed with worms. He died twenty-eight hours after taking the poison, and his death was preceded by great prostration of strength. The stomach, which was less inflamed than in the preceding case, shewed here and there some ecchymoses; the duodenum discovered slight inflammation; there was a broad ecchymosis in the ileum. The rectum was in its natural state.

Experiment. A strong and robust dog was made to swallow thirty grains of verdegris. The animal soon made great efforts to vomit; was agitated by convulsive movements: three

hours afterwards a hæmorrhage from the nose came on; he passed a great quantity of bilious matter, and died five hours after the poisoning.

The abdomen was distended by a great quantity of fetid gas: it contained likewise a bloody serum. The intestines were generally inflamed; the inflammation of the mucous membrane was less considerable than that of the peritoneal. The stomach, which was free from erosion, exhibited on its internal surface a greenish tint: the lungs were distended with blood. The brain exhibited no trace of inflammation or effusion.

332. We do not consider these facts to be of such a nature as to establish the opinion that verdegris acts especially upon the digestive canal, and that it is not absorbed. M. Drouard, in another series of experiments, which we shall give an account of, has obtained results, which appear to prove on the contrary, that this poison exerts a mode of action altogether different from that which he has pointed out.

Experiment. Two grains of verdegris dissolved in an ounce of distilled water, were injected into the jugular vein of a large dog. At the moment of the injection, the animal made motions, as if in the act of mastication and deglutition. Half a quarter of an hour afterwards, he vomited, and passed some stools. A fainting then came on, with rattling in the throat, and he died at the end of half an hour. The trachea and bronchia were filled with frothy mucosities; the great vessels were distended with black and fluid blood, which very easily coagulated.*

Experiment. The solution arising from verdegris treated by water, was evaporated to dryness, and half a grain of the verdet resulting from it, was dissolved in an ounce of distilled water, and injected into the jugular vein of a tolerably strong

* M. Drouard does not say in what state he found the mucous coat of the intestines. It is probable, on that account, that they presented no alteration.

dog. At the moment of the injection, the same movements of mastication and deglutition were observed. The animal vomited a quarter of an hour afterwards, and continued languishing until the third day, when the lower extremities appeared to be paralysed. During this time he only drank some water, and died on the fourth day.

On opening the body, the blood, the vessels, the digestive organs, presented nothing particular.

Do not the results of these two dissections prove, that the death occasioned by verdegris does not depend upon any inflammation of the digestive canal? Ought not the animal which survived four days from the injection, to have exhibited signs of inflammation in the gastric organs?

333. The following fact still further corroborates this assertion.

M. Drouard gave to a dog six grains of sulphate of copper. The animal died in less than half an hour, and on opening the alimentary canal, no vestige of inflammation or erosion could be perceived.*

334. I have had frequent opportunities of administering verdegris and the acetate of copper to dogs of different sizes, and I have constantly observed, that when the dose of acetate of copper introduced into the stomach was stronger than from twelve to fifteen grains, the animals died in less than three quarters of an hour; they could very seldom resist the action of the poison for an hour. The symptoms which preceded death were, a copious vomiting of a bluish matter, evidently coloured by a portion of the acetate of copper; fruitless efforts to vomit after the whole of the aliments contained in the stomach were thrown up; plaintive cries; an extreme difficulty of breathing, irregularity and frequency of pulse; frequently a general insensibility: the animal lay down and appeared to be dead; convulsive movements almost always

* The sulphate of copper most probably acts upon our organs in the same manner as the acetate of this metal.

took place; and a few moments before death a universal stiffness came on, with some tetanic twitchings, and a great quantity of foam from the mouth.

On examining the bodies after death, it was observed that the muscles shewed no sign of contractibility; the mucous membrane of the stomach was covered with a bluish coat containing a portion of the matter thrown in; this coat was hard, and as it were horny: when scraped off, the mucous membrane was perceived underneath of a rose colour. The trachea and bronchia were filled with a white foam. The lungs were crepitating, and presented a few rose-coloured spots on a pale ground. The heart had ceased to beat.

335. The injection of a grain of acetate of copper in half an ounce of water, into the jugular vein, occasions death commonly in the space of from ten to twelve minutes: the animal instantly makes motions, as if masticating and swallowing, which are followed by vomitings attended with painful efforts: he experiences great difficulty in breathing, becomes agitated with very violent convulsive motions, lies down instantly, becomes insensible, the rattling in the throat comes on, and he dies.

On opening the body, nothing remarkable is perceived about the organs of digestion: the contractile power of the muscles appears destroyed, the lungs present no alteration, and the heart is deprived of motion.

336. Let us take notice, 1st, that all the animals which die under the action of acetate of copper, present a series of nervous symptoms extremely well marked: such as convulsive movements, tetanic succussions, general insensibility, or paralysis of the posterior extremities: 2d, that death quickly supervenes, when this poison is introduced into the stomach, and more especially when it is injected into the veins: 3d, lastly, that the coats of the stomach and digestive canal are scarcely altered. Are not these facts of a nature to warrant the presumption, that this salt is absorbed, carried into the torrent of

the circulation, and produces death in consequence of its action on the nervous system? I confess, such would be my opinion, if one could be warranted to draw conclusions from a very small number of experiments. It is certain, however, that death is not the immediate result of the action of this poison on the digestive canal, as M. Drouard has affirmed.

Perhaps the lungs, likewise, may receive the impression of this poisonous substance: certain facts render this opinion at least probable; multiplied experiments, conducted with the greatest precision, can alone illustrate this important point of physiology.

SYMPTOMS OF POISONING BY VERDEGRIS.

OBSERVATION 1st.

On the 4th of September, 1772, M. Navier was called upon to visit, in the same house, nine patients poisoned by verdegris.

A young girl of eighteen, had eaten some cake made with melted butter, and skimmed with an instrument of copper, upon which the fat body had been allowed to cool. She experienced violent head-aches and copious vomitings. She was made to drink copiously, twenty-four hours after the accident, water, holding in solution a small quantity of some saline alkaline substance. She took afterwards an infusion of the pulp of cassia rendered emetic, and the principal symptoms speedily subsided. This girl was quickly cured by the use of a milk diet.

The father, mother, three young children, and a boy of eighteen, had eaten of the same cake, as well as some broth and meat coming out of a sauce-pan that had been skimmed with the same skimmer, and which had probably not been cleaned. Pains of the bowels, violent and frequent vomit-

ings, followed by a great prostration of strength, a small and tight pulse, and considerable head-aches: such were the symptoms which declared themselves. A slight decoction of linseed, a little alkaline, and edulcorated with the water of marsh-mallows and the syrup of poppies, was given them. Some hours afterwards a very slight infusion of the cassia pulp, but greatly sharpened, was given them. The effect of these medicines was to procure abundant evacuations upwards and downwards: at the end of eight days, the cure was completed. We must however except the mother, who, being naturally subject to vomitings, and endued with a nervous temperament, was more exhausted by the action of the poison, and fell several times into a state of syncope. She was at length however restored by persisting a long time in a milk diet.

The two other persons had eaten a fricassee of pigeons prepared with the soup, coming from the same pot. One of them between thirty and forty years of age, of a strong temperament, experienced considerable vomitings; the other, aged twenty years, who was strong and robust, did not feel the action of the poison till after several hours: he was, however, tormented by vomitings and violent pains of the head: shortly after an intense fever came on, and he fell into a state of lethargy, occasioned by the violence of the vomitings, and by a state of plethora. He was twice bled in the arm, and once in the foot; some slightly alkaline and laxative drinks were administered, and he was restored to health in the space of ten or twelve days. As to the first of these persons, he was treated in the same manner as the patients above described, and was cured in three days.*

OBSERVATION 2nd.

"M. Morizot-Deslandes was called in, on Monday, the

* Op. Citat. tom. i. p. 304, et seq.

9th of July, 1781, to the relief of the Jacobin Friars of the Rue St. Jacques, who were reported to have been poisoned. The patients, to the number of one-and-twenty, complained of very violent and painful colics, and were labouring under fever. In all of them, the first symptoms had been severe head-aches, accompanied with excessive weakness in the legs, and in the whole body; dull pains over the fore-part of the thighs, and in some, cramps in the calves of the legs. Those, who first felt the action of the poison, had experienced beside, a severe pain of the stomach, accompanied with anxiety of the præcordia which is peculiar to it, and a trembling of the limbs.

"In some, the symptoms did not shew themselves till the next day. M. Morizot was informed that the patients had eaten, for their Friday and Saturday's dinner, some ray, which had been cooked in a copper kettle; that the cook, after having taken out a part of the water, had poured vinegar upon them to render them more firm, and that the fish had remained in this state for some time in the sauce-pan, away from the fire. M. Morizot perceived two indications to be attended to; to weaken the force of the poison, and to drive it out of the body. He gave at first, milk diluted with four parts of water, a gummy water, weak meat broths, with emollient glysters. After four or five days, he administered gentle evacuants, such as the *cassia fistula* and manna dissolved in whey, and afterwards senna. The whole of the patients were cured in a short time."

It is added, that a stranger, who had dined at the convent, to whom an emetic had been given, was extremely ill, and was not yet recovered in the month of September.*

OBSERVATION 3rd.†

On the 3rd of July, 1778, M. Jeanroy, one of the most

* Drouard, Op. Citat. p. 34.

† Mémoires de la Société Royale de Médecine, p. 215, 1778.

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celebrated practitioners of the capital, was called in to see a man named By, and his wife, fruit-sellers, who had eaten both at dinner and supper, some veal, which had been kept in an earthen pot, on which was placed a copper lid. As there was a great quantity of the meat, it was pressed down by the lid, and became impregnated with verdegris. A person named Duval, and his wife, living in the same house, had likewise eaten some of it for dinner the same day. The first who experienced any bad symptoms, was the above-mentioned Duval. On the Thursday morning, at two o'clock, he was awoke by colics at the stomach, which were followed by vomitings. His wife a few hours after, complained of shooting and painful colics. The repeated use of milk and mucilaginous glysters proved sufficient for their cure.

The man named By, experienced the same day, about seven o'clock in the morning, severe pains at the stomach, nausea, and frequent vomitings. He perceived from time to time alarming colics, followed by contractions of all the limbs, and accompanied by profuse sweats. His wife experienced the same symptoms, with the exception of the colics, which were neither so violent nor so frequent: she complained much of her head. The pulse of both of them was small, unequal, and sometimes convulsive. Mucilaginous glysters, and milk, had been administered to them as to the two first. M. Jeanroy objected to the continuation of the milk; and as their tongues were very much loaded, and there could be no hope of relief but by clearing the stomach, he ordered for them a solution of emetic tartar in the dose of six grains to a pint and half of water. The husband took two grains, and the wife three. This method procured vomitings of a greenish bile, with lumps of coagulated milk, and the patients then experienced a decided relief. The woman felt no other complaint than slight pains at the stomach, and the husband than colics, which were felt for three days.

After having fulfilled the first indication by the emetic, M.

Jeanroy ordered to be given to the said By and his wife, for ordinary drink, a strong decoction of marsh-mallows root: beside which they took every half hour two spoonfuls of a mixture made with six ounces of oil of sweet almonds, two ounces of syrup of marsh-mallows, and an ounce of the syrup of *diacodium;* every two hours likewise were given glysters made with linseed, to which was added olive oil: in the evening a theriac bolus, and every four hours, some fat broth. By the use of these different means, the patients were in a short time out of danger.

OBSERVATION 4th.

N***, a working jeweller, aged forty-four years, being plunged into the deepest misery, resolved on poisoning himself; and on the 23rd of June, 1812, at midnight, he swallowed about four drachms of verdegris diluted with a small quantity of water. On the day of the 22nd and 23rd, N*** had taken nothing by way of nourishment, but a small quantity of sorrel soup: a quarter of an hour after having taken the poison, he was attacked with violent colics, abundant vomitings, and copious alvine evacuations; these symptoms still continued at five o'clock in the morning, when he was received into the *Hotel-Dieu.* Gum water was instantly administered to him, with milk and emollient glysters. Three hours after his admission, he presented the following appearance: the countenance sorrowful and melancholy; the eyes surrounded by a deep black circle; tongue moist; mouth clammy; anorexia; spittings, eructations of verdegris; thirst very intense, pulse small and regular, giving eighty pulsations in the minute. (Same treatment.) At half past two fresh vomitings of a deep green matter. At four o'clock icterus declared itself: during the night slight colics, continuation of the vomitings, three stools which brought a little relief, and sleep. The next day (second day from the accident,) jaundice very intense, expressed himself calm, tongue grayish, mouth clammy, with a

taste of verdegris, cessation of the coppery vomitings and eructations. Abdomen retracted, and very little sensible to pressure; pulse regular, and expanded; heat of skin natural; head heavy, slight degree of deafness. (The water of *Vichy* given with whey, and two emollient glysters.) The patient had in the course of the day four stools of a grayish substance. The 26th (third day from the accident), continuation of the same symptoms, general uneasiness, severe thirst; the urine turbid, of a deep red colour with a yellowish sediment. (The same treatment.) The 27th (fourth day), a marked diminution of all the symptoms, return of appetite, general debility. (Continuation of the same means; soup, and vermicelli.) The 16th of July, the icterus was entirely dispersed, and the patient was in a state of convalescence.*

OBSERVATION 5th.

M. Drouard reports, in the work above quoted, page 391, the following fact. "It is about ten years since, when I "began to apply myself to the study of medicine, by attend- "ing to that of pharmacy, that I took, through ignorance, "very near a drachm of a mixture of verdegris, honey, and "vinegar, improperly named *Unguentum Ægyptiacum.* I "had just been taking a copious breakfast. A quarter of an "hour after, I had coppery eructations, and a continual "spitting; which made evident the poisoning. An oily "draught was administered to me, and I was made to drink "milk: two or three hours afterwards, I felt a great pain of "the head, with thirst, and tolerably severe gripes; my belly "swelled so rapidly that I was obliged to loosen the waist- "band of my breeches: copious evacuations succeeded. A "physician, who was called in, recommended mucilaginous "drinks, and emollient glysters. The stools continued in "small quantity, with tenesmus, and loss of strength: they

* Observation communicated by M. Picquet de la Houssietté, M.D.

" did not cease till near the eighth day, when my convalescence " commenced. After this accident, I preserved such an " aversion to copper for a long time, that the smell of this " metal was sufficient to produce nausea."

OBSERVATION 6th.

Having been called upon to visit M. Dubroc, an old magistrate of Bayonne, I found him in his bed, with a continual vomiting, cramps of the extremities, convulsive motions and cruel pains of the abdomen: his wife and two maid-servants were attacked in the same manner, only that the symptoms in these last were not so complicated as they were in the person of M. Dubroc.

This induced me to decide, that this vomiting had been occasioned by something extraordinary. In fact, after a few questions, I learned that they had been eating eggs, with sorrel and butter, which had been prepared in a copper vessel, which I saw, and which was full of verdegris.

Having no longer any doubt but that it must be the acid of the sorrel which had divided a part of the copper, and that the symptoms proceeded from this metal which was irritating and corroding the coats of the stomach, and finding myself at this critical moment, destitute of resources, I resolved on giving M. Dubroc a full glass of vinegar; and to his wife, in whom the symptoms were less serious, half a glass.

Half an hour after they had taken the vinegar, the patients told me that they had felt in their stomach, a kind of effervescence very considerable; vomiting came on shortly after, and the symptoms were relieved. I gave afterwards a great deal of oil and emollient decoctions and glysters. A servant-girl, who had not taken the vinegar, well nigh lost her life, notwithstanding the chicken broth, emollients, theriaca, &c.*

* Journal de Médecine, Chirurgie, Pharmacie, tom. vi. Observation de M. Fabas, p. 552.

OBSERVATION 7th.

Professor Dupuytren relates, that a whole family were poisoned by eating lobsters, which had been cooked, and afterwards remained in a copper kettle, into which had been poured vinegar, with which it is the custom in some places to season them. Three persons, advanced in years, died from the consequences of this poisoning. The others survived.*

OBSERVATION 8th.

Two men having eaten of a ragout prepared in a copper vessel, which had been negligently tinned, died poisoned, after having experienced, for the space of about an hour, violent cardialgia, to which succeeded horrible vomitings and a continual tenesmus. Every remedy administered to them was useless. On opening the bodies, the alimentary canal was found distended with a great quantity of gas, corroded in several places, principally in the small intestines. The pylorus and duodenum were attacked with gangrene: the rectum was pierced through in two points; the œsophagus and pharynx appeared in their natural state.†

OBSERVATION 9th.

The child of a painter having swallowed some verdegris, died. On opening its body, the stomach was found inflamed, and very much thickened in its substance, especially towards the pylorus, which was swelled to that degree, that its orifice was nearly obliterated. The small intestines were inflamed throughout their whole extent, and gangrenous in several places, and even perforated, so that a part of the greenish liquor contained in the intestines was effused into the abdominal cavity; the great intestines were distended beyond mea-

* Drouard, Op. Cit. p. 74.

† Observation sur les Effets des Vapeurs Méphitiques dans l'Homme, par Portal, 1787, p. 436.

sure in some places, and very much drawn together in others: but the rectum was ulcerated throughout its whole internal surface, and perforated in several places.*

337. The symptoms of poisoning from verdegris may be reduced to the following.

An acrid, styptic, coppery taste in the mouth; parched and dry tongue; a sense of strangulation in the throat; coppery eructations, continual spitting, nausea, copious vomitings, or vain efforts to vomit: shootings in the stomach, which is often very painful, horrible gripes; very frequent alvine evacuations, sometimes bloody and blackish, with tenesmus and debility: the abdomen puffed up, and painful; the pulse small, irregular, tight, and frequent; syncope; heat of skin; ardent thirst; difficulty of breathing, anxiety of the præcordia, cold sweats, scanty urine; violent head-ache, vertigoes, faintness, weakness in the limbs, cramps, convulsions, and lastly, death.

It is rare that all these symptoms occur in the same individual: in general, the vomitings and colics, are the most constant. It sometimes happens that Gangrene seizes on the intestines: this state, always fatal, is announced by the sudden cessation of the pain; by the smallness, and excessive weakness of the pulse, which is almost imperceptible; by singultus more or less frequent, and by cold sweats.

LESIONS OF TEXTURE PRODUCED BY VERDEGRIS.

338. The seat of these lesions is principally in the digestive canal. When death takes place a few hours after taking the poison, the mucous lining of the stomach and intestines is found to be inflamed and gangrenous. Sometimes the inflam-

* Observation sur les Effets des Vapeurs Méphitiques dans l'Homme, par Portal, 1787, p. 439.

mation is communicated to all the coats of these viscera, and sloughs are formed, which are quickly detached, and leave openings, through which their contents pass out and are effused into the cavity of the abdomen.

The Observations 7 and 8, reported by M. Portal, furnish instances of such perforations as we have been speaking of. M. Laporte, a surgeon of Paris, has known a man to be killed in the course of a few hours, by a little ball of wax loaded with verdegris, which he inadvertently swallowed: in his stomach was seen a very considerable slough.*

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY VERDEGRIS.

FIRST CASE.

The Person is living; the rest of the Poison can be examined.

339. *A.* If the substance to be examined be in a solid form, and of a bluish green colour, a small quantity of it should be put into an earthen crucible, which should be heated to redness. If, by the action of heat, this substance becomes decomposed, grows black, and furnishes, in the space of a few minutes, metallic copper, it may be presumed, that it consists of verdegris, the certainty of which may be acquired by the following means: 1st. Concentrated sulphuric acid poured on a portion of this powder will set at liberty vapours of acetic acid, which may be known by their smell. 2nd. Boiling distilled water will only partially dissolve it, and the solution, which is of a blue colour inclining to green, will give a brown precipitate to the prussiate of potash, a clear blue to ammonia (this precipitate will re-dissolve entirely in an

* Encyclopédie Méthodique, Médecine, tom. v. 1re. Partie, p. 247.

excess of alkali), a blackish brown to sulphurated hydrogen, hydro-sulphurated water, or the hydro-sulphuret of potash; lastly, phosphorus and iron, being plunged into this solution, will be covered with a coat of metallic copper. (Vide § 310, et seq. *Chemical History of Verdegris.*)

B. If the verdegris be solid, and adhering to vessels of copper not tinned, or badly tinned, we should begin by scraping such parts of the utensils as present green points, and collecting the powder; which should be examined by the means we have just pointed out. If the quantity to be examined be inconsiderable, it should be brought into contact with sulphuric acid and boiling water, (§ 313, et seq.) and the character furnished by calcination may be neglected. In fact, these two re-agents are sufficient to demonstrate the presence of the acetic acid and of the oxyde of copper.

The inconvenience which would attend the calcination of so small a quantity of matter, arises from the difficulty of separating a sufficient quantity of copper to render it visible, and more especially from the impossibility there would be of deciding on the existence of the acetic acid.

C. It may happen that the copper vessels, so scraped, furnish a greenish powder, insoluble in water, and which dissolve with effervescence in sulphuric acid, without disengaging any acetic acid. This phenomenon ought necessarily to take place whenever the powder examined consists of natural verdegris (carbonate of copper). In these cases, which are not uncommon, it will be necessary to bring a portion of it in contact with acetic acid, concentrated, and at the ordinary temperature, which will quickly dissolve it, and furnish the acetate of copper of a greenish blue colour, the properties of which are very striking, and easy to ascertain with certainty (§ 313). Another portion ought to be calcined with charcoal in an earthen crucible, in order to obtain metallic copper.

D. If the verdegris has been diluted with cold water, the substance on which the practitioner has to act, will be partly

in a liquid, and partly in a solid form. The liquid portion, which will be of a bluish colour, will be turbid; it will contain acetate and sub-acetate of copper; it must be decanted, and treated by prussiate of potash, ammonia, and other tests which we have directed (§ 310 et seq.). The undissolved portion, which will be of a colour more or less dark, must be dried and calcined with charcoal. If metallic copper be by these means obtained, and the fluid portion beside shall have exhibited the same phenomena as the solution of acetate of copper, it may be decided that the substance examined is verdegris.

E. In such cases where the fluid, by reason of its mixture with wines, broth, &c. may furnish with the tests, precipitates which are of a different colour to those furnished by the solution of verdegris, it will be necessary to have recourse to evaporation. If the dried mass should give out with the sulphuric acid, vapours of acetic acid, and by calcination with charcoal it should furnish metallic copper, it may be decided, that it contains acetate of copper. In case the sulphuric acid should not disengage any vapours, calcination alone would be sufficient to determine that the liquor contained a preparation of copper.

In these kinds of investigations, we should always keep in mind, that the solution of verdegris in water is of a blue colour whilst free from mixture; but that it may present different colours according to the nature of the fluids with which it is combined.

F. If the acetate of copper forms part of an ointment, or any other fat substance, a part of the mixture must be calcined in order to obtain the metallic copper, and the rest submitted to the action of boiling water: if the solution obtained possesses the properties of acetate of copper, (§ 313 et seq.) it is evident that this salt forms part of the composition of the fat body. If the water should be colourless and should not contain a particle of the coppery salt, whilst however by calcina-

tion, the mixture furnishes metallic copper, we may presume that this metal does exist in it in the state of oxyde or carbonate of copper (natural verdegris.) In this case the practitioner, without seeking to decide upon the nature of the preparation of copper, ought to pronounce, that it does exist in the composition, and consequently is capable of being the cause of the symptoms which have made their appearance. It would not, however, be difficult to investigate whether it were the oxyde or carbonate of copper, which forms part of this poisonous preparation (§ 300, and 301).

SECOND CASE.

The Person is living: the whole of the Poison has been swallowed: the Matter vomited may be examined.

340. Of all the poisonous substances we have hitherto examined, there is none which imparts a colour to the matter vomited in so striking a manner, as the verdegris and other salts of copper. These colours indeed are not always the same; they are most commonly blue, the shades of which are various; sometimes they are green, yellow, &c.; differences which depend upon the different fluids and solids with which the verdegris has chanced to be mixed in the stomach. The circumstance then of the colour ought not to be regarded as a characteristic of the first importance in recognizing salts of copper in the matter vomited. In fact, how often has it happened that persons poisoned by the nitric acid have thrown up matter extremely green, the colouring of which has been attributed at first sight to verdegris, but which did not contain an atom of it. I have already witnessed two different cases of scirrhus of the pylorus, in which the matter vomited was of a bluish-green colour, in every respect similar to what animals poisoned by verdegris generally throw up; it has nevertheless been impossible to discover the smallest trace of this coppery salt. M. Guersent mentions his having opened the

body of a patient, who had died of some organic affection of the stomach; in whom, the liquids contained in that organ, presented a blue colour, similar to that furnished by the prussiates with the salts of iron, without however containing any metallic substances (*Dictionnaire des Sciences médicales*, tom. vii. p. 564). These facts are sufficient to make the juridical physician perceive the errors he might commit, if he attached a greater degree of importance to the colour of the matters vomited than they deserve.

A. If the matter vomited be liquid and transparent, its colour must be observed, and it must be treated by the tests proper for discovering particles of verdegris; such as the prussiate of potash, arsenite of potash, hydro-sulphurated water, the hydro-sulphurets, phosphorus, iron, and ammonia. If the precipitates obtained be of such a nature as to excite a suspicion of this species of poison (§ 315), the whole should be evaporated to dryness in a capsule of porcelain, and all the solid portion should be detached, in order to calcine it in a crucible, and to obtain the metallic copper. It is clear that by the action of heat, all the vegetable and animal principles, which can form a part of the liquor vomited, will be decomposed and converted into several volatile productions, and into charcoal; this combustible body will decompose the oxyde of copper, and reduce it to its metallic state. It is not uncommon to see iron remain several hours, and even days, before precipitating the metallic copper from the solutions of verdegris when mixed with animal matters. Phosphorus constantly effects this precipitation in a much shorter space of time.

If the fluids vomited be too much diluted, and should not furnish any distinct precipitate with the tests, it will be necessary to concentrate them by evaporation, and afterwards to make the experiments which we have just pointed out.

It may happen, that certain liquids vomited, which consist of several fluids both animal and vegetable, and verdegris, do

not furnish any precipitate with the re-agents of which we have just spoken; or that the precipitates, which they do furnish, are of a colour different from that which they would have presented if the experiments had been instituted upon the acetate of copper without any mixture: this phenomenon very frequently occurs when ammonia is employed to discover verdegris in animal fluids which contain wine (§ 326). In this case we must adhere to the character furnished by calcination, and not decide that poisoning has taken place by a preparation of copper until the metallic copper be obtained.

B. If the matter vomited be at the same time both solid and liquid, it must be passed through a piece of fine linen, and the liquid portion acted upon in the manner we have just pointed out. If the poison cannot there be discovered, the solid portions are to be dried at a temperature not much elevated, and treated by boiling distilled water, in order to dissolve the acetate of copper with which these substances may be mixed; this solution should be examined in the manner we have pointed out in treating of the *first case*, page 227: if it does not furnish a particle of copper, all the parts, which the boiling water has not dissolved, must be calcined in an earthen crucible; and if metallic copper be obtained, it may be decided that poisoning has taken place by a preparation of copper.

It is sometimes difficult to perceive the metal dispersed in small quantity amongst an infinity of molecules of charcoal, proceeding from the decomposition of the animal substances; in this case the product of the calcination must be put into water: in a short time the copper, being endued with a specific gravity much more considerable than that of the charcoal, subsides, whilst the black particles remain suspended.

It would be still better, in such a case, to pour upon the product of the calcination nitric acid at 25°; which would convert the copper into nitrate of copper of a blue colour: this should be filtered, and it will be easily recognized

by the proceedings which we shall point out hereafter, when treating of the nitrate of copper. (§ 361 et seq.)

THIRD CASE.

The Person is living: the whole of the Poison has been swallowed: the Vomitings can not be procured.

341. Chemistry cannot in any way throw a light on this difficult and embarrassing case.

FOURTH CASE.

The Person is dead.

342. The details which we have just gone into in the explanation of the first and second case, render it unnecessary to point out afresh the experiments which should be made in order to discover the most minute quantity of verdegris, when mixed and combined with the liquids or solids.

The mode of analysis is precisely the same as that which we have just recommended for the matters vomited.

It must however be remarked that, in certain cases no vestige of the poison is found in these substances, having been expelled almost entirely during life: in that case the lesions of texture must be noted, the mucous membrane of the stomach and intestines must be scraped off, dried, and submitted to the action of a strong heat in a crucible. I have twice obtained metallic copper, by calcining in this manner a portion of the membranes of the stomach of two dogs that I had poisoned with verdegris. This effect particularly takes place when the mucous membrane is of a bluish colour, hard, and strongly adhering to the substance of the stomach.

TREATMENT OF POISONING BY VERDEGRIS.

343. Does there exist any antidote to verdegris?

Navier, in his work on counter poisons, extols the hydro-

genated sulphurets of potash, of lime, and of iron, as substances which ought to decompose verdegris, and to transform it into an insoluble sulphuret of copper. M. Drouard has tried some experiments, the results of which destroy the assertion of Navier.

"These sulphurets, which are of themselves too irritating, "add to the dangers which we want to combat; and although "they actually produce the decomposition expected from "them, the precipitate still preserves enough of poisonous "properties to produce the most serious accidents, and even "death." *

Experiment 1. M. Drouard injected into the stomach of a tolerably strong dog, who had just swallowed fifteen grains of verdegris, four ounces of a solution of the sulphuret of potash. A quarter of an hour after, the animal made efforts to vomit, and threw up some brownish mucosities. He died thirty hours after. The mucous membrane of the stomach was violently inflamed in some points, and almost gangrenous in others.

Experiment 2. The same dose of sulphuret of potash was injected into the stomach of a dog, who had been made to take a few moments before, the same quantity of verdegris mixed with aliments: this animal likewise made efforts to vomit; he evacuated a liquid matter, black, and mixed with green: he died thirty-four hours after taking the poison. On opening the body, they found the stomach and duodenum inflamed; the small intestines presented some ecchymoses.

Experiment 3. Fifteen grains of verdegris were treated with water; the fluid resulting from it mixed with a solution of sulphuret of potash, was injected into the stomach of a tolerably strong dog. The same efforts to vomit, and death in the same interval of time.

Experiment 4. The other hydrogenated sulphurets furnished similar results.

* Drouard, Op. Citat. p. 50.

344. Neither can the saline alkalies and earths be considered as means capable of neutralizing the action of verdegris on the animal economy. They possess indeed, the power of decomposing the salt; but the oxyde of copper, which proceeds from this decomposition, is endued with the most energetic deleterious properties. All the animals to which I have given these alkalies mixed with verdegris have died in a very short space of time.

345. The infusion of galls, recommended by Mr. Chansarel in this species of poisoning, does not present sufficient advantages to merit the title of an antidote.

346. Of all the substances proposed up to the present day, as antidotes to verdegris, there is none so efficacious as sugar. M. Marcelin Duval, after having collected several facts, concludes "that sugar and its preparations are specifics against verdegris." We shall relate the principal cases which have induced him to draw this conclusion.

1st. M. Gallet, ex-apothecary in chief to the forces, was poisoned by verdegris; he had vomitings, colics, and other alarming symptoms. Sugared water and solid sugar taken in great quantity put an end to the symptoms. The next day he had two and twenty stools, and was completely cured.

2nd. M. Duval introduced into the stomach of a dog, by means of an elastic gum catheter, a solution of four drachms of the oxyde of copper in acetic acid. A few moments after, he injected four ounces of water saturated with sugar. He repeated it every half hour, and employed likewise twelve ounces of common syrup: the animal experienced cold shiverings, and some convulsive movements. The last injection was followed by a perfect calm; he fell asleep, and exhibited no sign of inconvenience afterwards.

3rd. D***, a gunner of the marine artillery, had committed some fault, which induced him to prefer suicide to the punishment which the law reserved for him. The 5th Ventose of the year 12, at four o'clock in the afternoon, he swallowed at

one effort an ounce and a half of the acetous oxyde of copper, in four ounces of water. A few moments after, he felt a sharp and excruciating pain in the epigastric region. He was extremely agitated, and obstinately refused every assistance. His officers had him conveyed to the principal hospital: D*** was delirious, had faintings and convulsions. The limbs and body became stiff, the jaws were locked: every thing announced the most imminent danger. M. Duret, gave him a glass of sugared water. Vomitings succeeded. The matter vomited was saturated with verdegris. The same drink was continued under the form of a syrup, so as not to overload the stomach. An hour had scarcely elapsed from the beginning of this treatment when the scene was altogether changed. All the spectators, who despaired of the life of this young man, perceived the most alarming symptoms by degrees disappear. Three hours afterwards he only complained of an ardent thirst, of a certain difficulty in deglutition, and of some gripes: the pulse unfolded itself. The same drink during the night. The next day, symptoms of *angiotenic* fever, the pulse frequent and hard; painful tension of the abdomen, obstinate constipation. The prescriptions of the day were the same, sugared drink, and emollient glysters. The day after, a slight inflation of the belly, cephalalgia, sore throat, hardness of pulse, heat of skin. To the prescriptions of the evening was added a bleeding. The third day a cessation of the symptoms. A general relaxation took place, sweats, copious stools, and urine. The convalescence was short and fortunate.

4th. the 21st Frimare, year 12, at the officers' mess of the schooner *La Fine* was served up a rice pottage, which had been made in a saucepan of copper badly tinned, and left in it for several hours. Shortly after, two officers complained of rending pains at the pit of the stomach, of gripings in the bowels, and had violent vomitings; symptoms which disappeared by the use of sugar and sugared water. The surgeon

and the purser experienced dreadful colics. They drank syrup, and were not long before they experienced a perfect calm. They had a great number of stools.*

347. It appeared to me useful to try some experiments in order to determine whether the advantages obtained by sugared water depended on the sugar, or on the liquid which contained it.

Experiment 1st. I gave to a great dog fifteen grains of verdeter, pulverized, and incorporated with the crumb of bread; two minutes after, I made him take two ounces of white sugar in powder: at the expiration of a quarter of an hour, the animal uttered plaintive cries, which immediately ceased, but which recommenced at the end of eight minutes; several hours afterwards the animal appeared strong and in good health. The next day he was very lively and extremely active, and made his escape without any person being able to catch him.

Experiment 2nd. I caused another tolerably strong dog, to swallow twelve grains of pulverized verdeter; immediately afterwards I gave him two ounces of raw sugar; at the end of ten minutes came on vomitings of mucosities in no great quantity, of a green and whitish appearance, accompanied with plaintive cries; shortly after, fresh vomitings of a greenish matter, convulsive movements of all the muscles, violent startings, greenish stools, great efforts to vomit, but without success. Four and twenty hours afterwards the animal was in very good health, and had made his escape as the other had done.

Experiment 3rd. I gave another dog two ounces of liver to eat, into which I had inserted five and twenty grains of verdegris, perfectly pulverized; immediately afterwards, I made him take six ounces of coarse sugar in powder. During the two first hours the animal shewed no sign of pain, but all

* Marcelin Duval, Op. Cit. p. 33.

at once he was seized with vomitings of a green matter in tolerable abundance, and thrown up without effort; these vomitings ceased in the course of ten minutes: the animal lay down, had two stools, and the next morning was nearly restored: two days afterwards, I began to feed him with milk; he was perfectly cured in the space of six days.

Experiment 4th. A fourth dog of middling size, and already weakened by a former experiment, took fifteen grains of verdeter; immediately afterwards I obliged him to swallow two ounces of coarse sugar in powder: vomitings of yellowish matter with plaintive cries; and at the end of twenty minutes, fresh vomitings of a thick matter of the colour of verdeter, next morning the animal was in good health.

It is evident that in all the experiments I have just reported, the solid sugar* prevented the death of the animals that had taken verdegris, since ten or twelve grains of this substance are sufficient to kill them.

The following fact confirms the results of the preceding experiments. M. P*** was attacked, without any known cause, with severe gripes, coppery eructations, and vomitings of greenish matter. He believed himself to be poisoned by verdegris, and swallowed half a pound of solid sugar: all the symptoms disappeared as by enchantment: an attentive examination of the different instruments of copper employed, soon brought to light the cause of the symptoms: in fact he discovered that he had been eating eggs prepared with melted butter, and allowed to cool in a vessel of that metal, which was covered over with verdegris.

348. I wished to determine what is the kind of action which sugar exerted upon the acetate of copper: if a mixture be made of twenty parts of water saturated with sugar, and one part of a solution of verdegris, neither turbidness nor any change of colour are perceived; and the liquid gives a

* The animals to which I administered verdegris and solid sugar had not taken any liquid for four and twenty hours.

brown precipitate with the prussiate of potash, a black with the hydro-sulphurets, and a blue with ammonia: from which it must be concluded that it contains a coppery salt.

If thirty grains of verdegris be made to boil for a quarter of an hour, with half an ounce of white raw sugar and two ounces of water, the liquor becomes of an extremely beautiful grass-green colour; prussiate of potash, ammonia, and the hydro-sulphurets, precipitate it, as in the preceding experiment: phosphorus becomes covered with a coat of copper; but potash precipitates from it a flaky substance of a greenish colour, which easily dissolves in an excess of alkali. The manner in which potash acts with this solution, and the green colour under which it presents itself, prove already, that the verdegris has undergone some alteration, by its mixture with the sugar.

If two ounces of unrefined sugar be triturated for a quarter of an hour in a glass mortar, with fifteen grains of verdegris reduced to powder, and half an ounce of water, the mixture quickly puts on a very beautiful grass-green colour. If it be diluted with a small quantity of water in order to filter it, and some prussiate of potash be poured upon this transparent fluid, the mixture affords a red colour; but it does not deposit any precipitate: whilst the same quantity of verdegris triturated simply with an ounce of water, furnishes in the space of five minutes, a blue liquid, which is copiously precipitated by the prussiate of potash. It must then be concluded from this experiment, that by trituration, sugar decomposes verdegris; or at least, renders it nearly insoluble in cold water.

If one ounce of loaf sugar, and one ounce of water, with ten ounces of verdegris, be made to boil in a phial for half an hour, a green liquid will be obtained, which does not contain a single particle of copper, since it undergoes no change by the prussiate of potash, ammonia, or the hydro-sulphurets. The bottom of the phial will contain a green powder without any shade of blue, insoluble in boiling water, and which dissolves

with effervescence in the diluted nitric acid, which it transforms into nitrate of copper. This experiment evidently proves, that the portion of acetate of copper contained in the ten grains of verdegris has been decomposed, and rendered insoluble by its mixture with the ounce of sugar.

From these experiments, it is certain that sugar exercises a chemical action upon verdegris. What is this action? In what state does the verdegris remain? What is the nature of the new body? These are questions which I propose to resolve hereafter.

349. The first care of the physician called in to persons recently poisoned by verdegris, should be to make them take a great quantity of solid sugar, and to administer to them plenty of sugared water: by this means the deleterious action of the poison will be greatly weakened, and the stomach filled with fluid, a circumstance which greatly favours vomiting. If however sugar cannot be easily procured, the patient must be plied with warm water, or even cold water, or with emollient decoctions, broth, or other liquids of the same nature; the throat should at the same time be irritated with the finger, or with a feather. If notwithstanding these means, vomiting does not take place, a solution of tartar emetic may be had recourse to; provided the pains of the stomach be not extremely violent: for in that case, it would be imprudent to introduce any irritating medicine. M. Jeanroy has employed this preparation with success in the patients which formed the subject of the third observation. This remedy ought more particularly to be had recourse to, when there are any symptoms of oppression of the stomach.

The elastic gum tube of M. M. Renault and Dupuytren ought to be employed in those cases where vomiting cannot be excited by the use of the means we have just pointed out; (*vide* the description of this instrument, § 84.)

350. Vinegar has sometimes been useful in favouring vomiting; the 6th observation, reported by M. Fabas, appears

to be favourable to it. Since, however, this acid does not always produce vomiting, and by remaining in the stomach increases the poisonous action of the verdegris; we are of opinion that it ought to be rejected in the treatment of poison by verdegris.*

351. If the poison has been some time swallowed, if it has already entered the intestinal canal, if the patient has vomited considerably, and been labouring under violent colics, we must carefully abstain from provoking the vomiting afresh, which will be useless, and even dangerous; emollient glysters, cooling, mucilaginous, and oily drinks ought to be employed and continued, until the principal symptoms be relieved. Milk ought to hold the first rank among the medicines of this class, notwithstanding the opinion of M. Drouard, who pretends that it ought to be rejected, because it quickly becomes decomposed in the stomach, and forms a solid and irritating coagulum. It is difficult to conceive that this mass should acquire a sufficient degree of hardness to act as an irritating substance, or that it would not be dissolved by the juices of the stomach.

352. Leeches, bleeding, warm baths, emollient fomentations, &c. are the means to which the practitioner ought to have recourse, in cases where inflammation of the viscera shall have made its appearance. Narcotics and antispasmodics ought to be employed, in order to remedy the different nervous symptoms which may occur, such as spasms and convulsions.

OF THE ACETATE OF COPPER. (CRYSTALS OF VENUS.)

353. This salt is of a deep blue colour; its taste is strong and styptic; it crystallizes in rhomboidal figures; is efflorescent

* In fact, vinegar transforms the verdegris into a soluble acetate of copper, the deleterious action of which is extremely energetic. All the animals to which M. Drouard gave vinegar, after having administered to

and easily soluble in water, without leaving any residue, which distinguishes it from verdegris; for the rest, when dissolved in this liquid, it possesses the same properties we have just described when speaking of verdegris (§ 313 *et seq.*).

354. M. Drouard has ascertained by a great number of experiments, that this salt acts with greater energy than verdegris. The animals which took a few grains of acetate of copper, died two or three hours afterwards; whilst others did not die till after many hours by the same dose of verdegris. On opening their bodies, the stomach is found to be inflamed, and of a brown red colour.

OF SULPHATE OF COPPER.

355. This salt, known also by the name of *blue vitriol*, is composed of sulphuric acid, and oxyde of copper at maximum (deut-oxyde of copper). Its taste is acrid, metallic, styptic, and almost caustic; it crystallizes in rhomboids, or prisms, with four sides.

356. Being heated in a crucible, it loses its water of crystallization, swells, and becomes white; which proves that the blue colour, which it commonly presents, depends on its union with water.

Sulphate of copper pulverised and mixed with an equal bulk of charcoal, being heated to redness in an earthen crucible, becomes decomposed, and gives out metallic copper, which is fixed; and sulphureous acid gas, and carbonic acid gas, which escape.

Rationale. The charcoal seizes upon a portion of the oxygen of the sulphuric acid, which causes it to pass into the state of sulphureous acid gas; whilst at the same time itself is converted into carbonic acid: the oxyde of copper, which re-

them verdegris, died in a very short space of time; and on opening them, their stomachs were found contracted, and covered with a green viscous coat—the mucous membrane was of a brown red colour.

sults from it is decomposed, and revived by another portion of the charcoal.

357. Sulphate of copper dissolves very easily in water: the solution is of a bluish colour. The alkaline salts, the hydro-sulphurets, and prussiate of potash, iron, and phosphorus, act with it as with the acetate of copper; it is not the same however with the water of barytes: this alkali precipitates it in abundance, and the precipitate, which is of a bluish colour, is composed of the sulphate of barytes, which is white, and of the oxyde of copper, which is blue. In fact, when treated by pure nitric acid, it disappears in part; the whole of the oxyde dissolves in the acid, which becomes of a blue colour; and the sulphate of barytes remains, which is of a very beautiful white.

358. Sulphate of copper reduced to a fine powder, and brought in contact with sulphuric acid, does not undergo any decomposition. There is neither effervescence, nor disengagement of any vapours: this character united to the preceding, is sufficient to distinguish this salt from the acetate of copper, and from verdegris; the history of which we have just given.

359. Can it be determined after death, that a person has been poisoned by a preparation of copper? Some authors have recommended, that the matters contained in the stomach should be treated by water, and muriate of barytes poured into the solution; if a precipitate of sulphate of barytes, which is insoluble in the nitric acid, be obtained, it may be decided from this character alone, that the poison was sulphate of copper. But it must be observed, 1st. That the alimentary matters, whether liquid or solid, frequently contain sulphates which would precipitate with the muriate of barytes. 2nd. That it is not sufficient to obtain a white precipitate, insoluble in nitric acid, in order to decide on the existence of sulphuric acid; for that purpose it will be necessary to heat the sulphate of barytes with charcoal, and to transform it into a

sulphuret, which may be recognised by water and muriatic acid (§ 120). For these reasons, the process above mentioned will be defective, even in those cases where the precipitation of the liquor by muriate of barytes, belongs exclusively to the presence of sulphate of copper.

We do not consider this problem sufficiently important of itself to require us to give a detail of the proceedings to which it would be necessary to have recourse, in order to come at a satisfactory solution of it.

We affirm only, that by the evaporation of the fluid, the sulphate of copper ought to be obtained either crystallized, or in mass, which may easily be recognised, by paying attention to the properties we have pointed out.

OF THE SULPHATE OF AMMONIACAL COPPER.

(AMMONIA SULPHATE OF COPPER.)

360. The sulphate of ammoniacal copper is of a beautiful blue colour. It may be distinguished from sulphate of copper, 1st, by the smell of ammonia which it exhales; 2nd, by the property it possesses of turning the syrup of violets green; 3rd, by the green precipitate which it furnishes with the arsenious acid in solution. This precipitate, which consists of arsenite of copper, is in great abundance, and appears instantly; whilst this acid, when brought in contact with sulphate of copper, does not produce any distinct precipitate till after the expiration of twenty, or five and twenty minutes.

OF NITRATE OF COPPER.

361. The nitrate of copper is of a beautiful blue colour; its taste is acrid, and extremely caustic; it crystallizes in elongated *parallelipipedes*, or in fine prisms like needles.

362. When put on burning coals, it dries and detonates with scintillation. If heated in a crucible it becomes decomposed, gives out oxygen gas, red nitrous vapours (nitrous acid gas,) and brown oxyde of copper. If it be mixed with charcoal, and submitted to the action of caloric, its decomposition is more complete, and it leaves for a residue metallic copper.

363. Nitrate of copper dissolves extremely well in water; this solution concentrated, when treated by the sulphuric acid, furnishes, in the course of a few moments, crystals of sulphate of copper, which proves that the sulphuric acid has a greater affinity for the oxyde of copper than the nitric acid, and that the sulphate is less soluble than the nitrate of this base. This character serves to distinguish these two salts. The hydro-sulphurets, prussiate of potash, ammonia, and arsenite of copper, act with this solution as with that of the acetate of copper.

OF MURIATE OF COPPER.

364. The muriate of copper at the maximum of oxydation is of a green colour, when in a solid form.

365. When heated in an earthen crucible with its bulk of charcoal and alcoholized potash, it is decomposed, and gives out carbonic acid gas, together with a fixed product, consisting of muriate of potash and metallic copper.* The potash in this operation, carries off the muriatic acid from the oxyde of copper, which is reduced by the charcoal to a metallic state, by its seizing on the oxygen it contains.

* These bodies may be easily separated by distilled water, which dissolves the muriate of potash without exerting any action upon the metal. The solution obtained by this means, precipitates by nitrate of silver, and the precipitate, consisting of muriatic acid and oxyde of silver, is insoluble in nitric acid (§ 40).

366. Muriate of copper, treated by boiling distilled water, gives a fluid of a green colour bordering on blue. This liquid furnishes by means of nitrate of silver, a white precipitate of muriate of silver; the hydro-sulphurets, hydro-sulphurated water, arsenite of potash, prussiate of potash, ammonia, and the other tests, render it turbid, as we have observed in giving the history of the solution of verdegris.

367. Concentrated sulphuric acid, when brought in contact with pulverized muriate of copper, decomposes it with effervescence, disengages from it muriatic gas under the form of thick white vapours of a pungent smell, and converts it into sulphate of copper.

368. Muriate of copper is seldom the object of medico-legal research: what we have said, is sufficient to distinguish it from the other salts of this kind, when it has not been mixed with the food.

If it has been introduced into the stomach in small quantity, it is almost impossible to ascertain its existence. In fact, in treating the substances contained in this viscus by water, a solution is obtained, which contains, besides this muriate, all those which formed part of the aliments, whether solid or liquid; so that it becomes extremely difficult to decide whether the muriatic acid found in this solution proceeds from the muriate of copper, or from the other muriates. In these kind of cases the practitioner should confine himself to demonstrating the presence of a preparation of copper, without any regard to the nature of the acid which may enter into its composition.

OF AMMONIACAL COPPER.

369. Ammoniacal copper is a combination of the oxyde of copper and ammonia. It is of a beautiful blue colour, so much the deeper as it is more concentrated; it possesses a sharp, penetrating ammoniacal smell.

370. The presence of copper may be demonstrated in it by the tests which we have already enumerated. Hydro-sulphurated water, the hydro-sulphurets, prussiate of potash, &c. (*History of Verdegris*, § 310, &c.) It differs from the sulphate of copper, and from the sulphate of ammoniacal copper, in that it contains no sulphuric acid, and consequently it does not furnish with the water of barytes a precipitate of sulphate of barytes, which is insoluble in the nitric acid (§ 357). Nitrate of silver never produces any precipitate of muriate of silver insoluble in pure nitric acid: which distinguishes it from the muriate of copper and the muriate of ammoniacal copper. Lastly, in evaporating it to dryness, no mass is obtained which fuses on burning charcoal, and which becomes decomposed in the fire after the manner of nitrates (§ 362); so that it cannot be confounded either with the nitrate of copper, or with the nitrate of ammoniacal copper.

OF COPPERY WINE AND VINEGAR.

371. If it be remembered with what facility the acetic acid dissolves the oxyde of copper, it will not appear astonishing that acid wines, which remain long in vessels of copper encrusted with verdegris, should hold in solution a certain quantity of that substance.

372. Of all the means proper for demonstrating the existence of a preparation of copper in liquors of this kind, the preference ought to be given to that, which consists in evaporating to dryness, and calcining, the residue with charcoal, in order to obtain metallic copper. If we confine ourselves to the employment of chemical tests, we may be led into error. Indeed, in consequence of its mixture with wine and vinegar, verdegris no longer furnishes the same precipitates as when alone (v. § 326, *action of wine on the Solution of Verdegris*).

OF COPPERY SOAPS.

373. However complicated may be the composition of coppery soaps and *Savonnules*, the metallic copper may always be obtained by calcination. The details into which we have already entered, in giving the history of the different preparations of copper, render it unnecessary to dwell any longer on this subject, which is of little importance.

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ARTICLE V.

SPECIES V.—THE PREPARATIONS OF TIN.

Var. 1st. The muriates of tin.
2nd. The oxydes of tin.

375. It is of importance to draw the attention of practitioners to the preparations of tin; the anthelmintic properties lately ascribed to the muriate of this metal by the German physicians, the great use made of it in France these late years, with the same intention; lastly, the frequent use of this salt in the art of dying, are so many considerations which have induced us to make known its fatal effects. Before giving the history of the muriates of tin, we are of opinion that it would be best to give an account of the principal properties of the metal which enters into their composition.

OF TIN.

376. Tin is a solid metal, the colour of which very much resembles that of silver. Its specific gravity is as 7,251. It is sufficiently malleable to allow of very thin plates being formed of it, but it draws out badly in wire, When twisted in different directions, it gives out a peculiar kind of crackling sound; which is called the *cry of the Tin.*

377. Exposed to the action of caloric, it easily enters into fusion: it is not however volatile.

378. Oxygen is capable of entering into combination with this metal, and gives rise to three oxydes, the properties of which differ in proportion to the quantities of oxygen which

enter into their composition; they are all however, capable of being decomposed, when calcined in a crucible with charcoal: this combustible body lays hold of the oxygen which they contain, passes into the state of carbonic acid gas, or of carbonic oxyde gas, and the tin is set at liberty.

379. If this metal be heated together with the nitric acid of commerce, there will be obtained a tritoxyde of tin, (oxyde of tin at maximum) in the form of a white powder; nitrous gas, which in the air becomes converted into nitrous acid gas, of an orange yellow colour;* and, lastly, nitrate of ammonia, which may be separated by filtering and evaporating the liquor. *Rationale* (*Vide* § 208, *page* 164, *et seq.* 1*st Part.*) The tritoxyde of tin thus obtained, is soluble in muriatic acid, and gives a muriate which furnishes a yellow precipitate with the hydro-sulphurets, and in which distilled water produces no turbidness.

380. Tin, when introduced into a mixture made with three parts of muriatic acid and one of nitric acid, dissolves at the ordinary temperature, and gives protomuriate of tin, the properties of which are described, § 383.

This metal possesses no poisonous property whatever, as any one may convince himself by consulting the memoirs published by Bayen and Charlard, and by M. Proust.†

CHEMICAL HISTORY OF THE MURIATE OF TIN.

The muriate of tin which now occupies our attention is that employed in commerce. Analysis has proved to me that it almost always consists of a great proportion of the muriate

* There is likewise disengaged in this experiment azotic gas, and protoxyde of azote.

† Recherches Chimiques sur l'Etain, par Bayen et Charlard, Paris, 1781. Proust, Annales de Chimie, tom. LI et LVII.

at minimum (proto-muriate), and of a certain quantity of muriate at maximum with excess of base (sub-deuto-muriate); it contains beside, a ferruginous salt.

381. The muriate of tin of commerce, is generally met with in the form of small needles, united by *fascia*, of a yellowish white colour. It has a very strong styptic taste, attracting the moisture of the atmosphere; and reddening the infusion of tournesol.

382. When thrown on burning charcoal, it becomes partly volatilized, and diffuses a thick smoak of a pungent smell.

383. Distilled water does not dissolve it entirely, whatever may be its temperature; which circumstance is owing to the insolubility of the sub-deuto-muriate that it contains. The portion dissolved, consisting of the proto-muriate, is transparent and colourless, reddens the infusion of tournesol, and may be decomposed by a great number of re-agents, but principally by such as are capable of yielding it any quantity whatever of oxygen.

A. On being heated in the open air, it lays hold on the oxygen, becomes instantly turbid, and is converted into sub-deuto-muriate.

B. Mixed with sulphureous acid, it decomposes it, and precipitates sulphur: the precipitate is milky, and of a white colour slightly inclining to yellow.

C. By its union with the solution of deuto-muriate of mercury, (corrosive sublimate,) a white precipitate instantly appears, consisting of proto-muriate of mercury, (vide § 41.)

D. The deuto-muriate of gold, poured into the solution we are speaking of, most commonly produces a purple precipitate. This precipitate consists of the deutoxyde of tin, and of metallic gold, according to some chemists; according to others, the gold is in the state of protoxyde: which proves, that the protoxyde of tin has entered into combination with part of the oxygen contained in the deutoxyde of gold.

E. The hydro-sulphurets render it instantly turbid, and separate from it a blackish powder formed by the hydro-sulphuret of tin mixed with a small quantity of hydro-sulphuret of iron.*

F. When prussiate of potash is added to the solution of the proto-muriate of tin of commerce, a white precipitate is obtained, which soon becomes blue by the contact of the air, and which consists of prussiate of tin, and prussiate of iron. *Rationale.* (vide § 42.)

G. Water saturated with sugar, does not occasion any change in this solution.

H. It is abundantly precipitated of a clear yellow colour by a strong infusion of tea, and by the infusion of galls in alcohol.

I. If a small quantity of proto-muriate of tin in solution be dropped into Burgundy wine, the fluids become immediately turbid, and a sediment is formed of a violet colour.

K. Albumine precipitates this salt of a white colour; an excess of albumine or of the proto-muriate of tin easily redissolves the precipitate.

L. Gelatine, poured into this metallic solution, immediately decomposes it, and produces a white flaky precipitate in tolerable abundance.

M. Amongst the animal fluids, there is none, of which the action on this solution is so remarkable as that of milk. A few drops of the proto-muriate are sufficient to convert a large quantity of this fluid into thick curds. These curds, washed and dried, are of a yellow colour, friable, and hard enough to be reduced to powder; in their smell and appearance they resemble dried cheese; and they do not easily undergo any change from the air. Analysis has proved to

* The solution of the proto-muriate of tin, free from iron, precipitates, by means of the re-agents, a hydro-sulphuret of tin of a chocolate colour.

me, that they contain, beside the animal matter, muriatic acid and oxyde of tin. Being heated with a solution of alcoholized potash, they become decomposed, and partly dissolved; the potash unites with the muriatic acid, and, if the liquor be filtered after twelve or fifteen minutes' ebullition, by the addition of nitrate of silver, a precipitate consisting of the muriate of that metal may be obtained (§ 21). If, instead of employing the solution of potash, this alkali be used in a solid form, and the mixture be calcined in a crucible, it will be soon seen that the animal matter is decomposed, giving rise to a charcoal, which unites with the oxygen of the oxyde of tin, and the metal becomes revived. The tin thus obtained is of a yellowish white, and may be easily known by its action on the concentrated nitric acid, and on the nitro-muriatic acid (§ 380 and 379). When it is impossible to separate, or even to distinguish the metallic points, scattered throughout so great a quantity of charcoal, the existence of this metal may be proved by treating the mass with the nitro-muriatic acid, which would transform the tin into the proto-muriate.

N. Human bile brought into contact with the proto-muriate of tin, gives rise to flaky curds as it were separated into filaments of a clear yellow colour.*

ACTION OF THE MURIATE OF TIN ON THE ANIMAL ECONOMY.

384. When a small quantity of the muriate of tin is injected into the veins, or introduced into the stomach of a

* It would not be altogether useless to point out in a succinct manner the characteristic properties of the pure muriates of tin; as the proto-muriate is employed in the laboratories, and the deuto-muriate in certain manufactories.

PROTO-

dog, death quickly succeeds, and is preceded by very severe symptoms. What is the cause of the symptoms produced by this salt? What are the organs on which it acts? I have attempted a great number of experiments in order to resolve this important problem.

Experiment 1st. At twenty-five minutes past nine, three quarters of a grain of muriate of tin dissolved in two drachms and thirty-six grains of distilled water, was injected into the jugular vein of a little dog, a year and half old. The animal did not experience any sensible inconvenience during the three first hours after the injection. At one o'clock he appeared oppressed, sorrowful, fatigued, and much less active than before the operation; he refused to eat. At five he was become insensible; he might be pinched or pricked without shewing the least sign of pain; and when made to take any position, he preserved it in such a manner, that one would have thought he was immoveable, and thus presented to us a remarkable instance of very singular catalepsy; nevertheless, when pushed, he made two or three steps, staggered, and fell down on one side or the other. The posterior limbs, although pliable, were much less so than the anterior; his breathing was nearly free, and he uttered no plaintive cry. At seven o'clock his breathing was very much accelerated, and extremely difficult, his pulse frequent, and the animal could not

PROTO-MURIATE.

It acts with the different re-agents as we have described, § 383, from A to N, except that the hydro-sulphurets precipitate it of a chocolate colour, and the prussiate of potash of a white, slightly inclining to yellow. When calcined with potash and charcoal, it yields metallic tin.

DEUTO-MURIATE.

The solution of this salt undergoes no alteration from the sulphuric acid, nor from that of the deuto-muriates of mercury and gold: the hydro-sulphurets throw down with it a yellow precipitate. When dried and calcined with charcoal and potash, it furnishes metallic tin.

stand on his legs for a moment, just as if he were dead. The muscles of the extremities and of the neck, being laid open, did not contract, and it was with difficulty some few movements could be excited by pricking them strongly with the point of a knife: these punctures however did not recal the sensibility. All these symptoms acquiring fresh strength, the animal expired at half past nine in the evening.

Appearances on Dissection.

The two middle lobes of the lungs were found of a red colour inclining to violet, not at all crepitating, of a close texture, gorged with blood, and did not float in water: the other lobes were in a natural state. The mucous membrane of the stomach and duodenum was rather redder than common.

Experiment 2nd. Two grains and a quarter of muriate of tin, dissolved in two drachms and thirty-six grains of water, were injected into the jugular vein of a little dog; the animal died fifteen minutes after the injection. During the first five minutes he did not experience any sensible inconvenience; when, all at once, the muscles of the face were agitated with convulsive movements; the anterior limbs became stiff and stretched like cords; respiration became difficult; death was preceded by an attack of tetanus, in which the head, being strongly contracted, was turned backwards.

Appearances on Dissection.

Examination of the body immediately after death, proved that the blood contained in the left ventricle, and in the arteries was of a deep red colour. The lungs were shrivelled and exhibited a few black patches.

Experiment 3rd. Six grains of muriate of tin, dissolved in one drachm and thirty-six grains of distilled water were injected into the jugular vein of a small dog; the animal expe-

rienced some vertigoes; his respiration was panting; and he died one minute after the injection.

Appearances on Dissection.

The right auricle of the heart only contracted slightly: the blood contained in the left ventricle was of a blackish red colour; the lungs were less crepitating than those of another dog which had died from suffocation; their texture was close and wrinkled.

It may be concluded from these experiments, that muriate of tin injected into the veins, acts with great energy upon the nervous system. Probably too, it exerts an action upon the lungs.

Experiment 4th. At ten in the morning, the œsophagus of a middle-sized dog was detached, and a hole was pierced in it, by which eighteen grains of muriate of tin in a solid form were introduced into the stomach inclosed in a paper cone. Immediately after, the œsophagus was tied below the opening, in order to prevent vomiting: at the expiration of forty minutes the animal made violent efforts to vomit; he appeared dejected, and lay down on his belly. The next day his dejection continued; there were neither convulsions nor paralysis. The animal died on the night of the third day.

Appearances on Dissection.

The mucous membrane of the stomach was of a blackish red over almost the whole of the part round the pylorus: it was hardened, horny, and, as it were tanned; the other part was of a clear rose colour. That part which lines the interior of the duodenum, and of the jejunum, was red in patches. The stomach and intestines contained a great quantity of bile, which was black, thick and stringy; the lungs were sound.

Experiment 5th. At one o'clock, forty-four grains of muriate of tin in a solid form, were given to a dog of middle size, and fasting. Five minutes afterwards, he vomited, without any effort, a small quantity of white frothy matter. These vomitings were repeated three times in the first twenty minutes after the ingestion of the poison, and it was only after very violent efforts that he was enabled to throw up, the last time, a small quantity of a white matter slightly inclining to yellow. At nine in the evening his fore legs were agitated by some convulsive motions, and the animal uttered plaintive cries. He died during the night.

Appearances on Dissection.

The mucous membrane of the stomach was of a dark red colour, hardened, tanned, and ulcerated in ten or twelve points. The lungs were apparently in the natural state.

Experiment 6th. A circular wound of an inch diameter, made in the back of a small dog, was sprinkled over with two drachms of muriate of tin; and, in order to fix the salt in its situation, the flaps of the wound were united by three stitches. The parts in immediate contact with the corrosive were scarified, and the subsequent inflammation was so considerable, that by the fourth day, the flaps and the subjacent flesh had come away, and left exposed a circular surface of about three inches diameter: the animal continued to eat, and breathed without difficulty. On the twelfth day, the wound being still open, and discharging a great quantity of matter, the animal died without any other remarkable symptom, than a great degree of emaciation and languor.

Appearances on Dissection.

The lungs and the mucous membrane of the intestinal canal did not exhibit the slightest alteration.

If it be considered, that a very small quantity of the

muriate of tin, introduced into the torrent of the circulation, occasions death in the course of a few minutes; and that from the symptoms and organic lesions it may be inferred, that life becomes extinct only in consequence of the injury sustained by the nervous system, and perhaps by the lungs (Exper. 1st, 2nd, and 3rd.); we shall be forced to conclude that this salt has scarcely been at all absorbed in any of the three last experiments. Death, on the contrary, appears to have been the consequence of the corrosion and inflammation of the organs, with which the poison has come in contact. In the fifth experiment only, the brain appears to have been affected by sympathy, on account of the numerous nervous ramifications by which it is connected with the mucous membrane of the stomach. Several corrosive poisons act in a manner analogous to that I have been speaking of, which induces me to believe *that the same poisonous substance may exercise its fatal action on this or that organ, according to the point with which it has been brought in contact.*

SYMPTOMS OF POISONING BY THE MURIATE OF TIN.

OBSERVATION.

A manufacturer of sulphuric acid, in the neighbourhood of Rouen, had brought from the town, a small parcel of muriate of tin, which he wanted for trying some experiments he had proposed making, and had laid this parcel upon the chimney-piece. The cook, who had been asking for some salt, which she was in want of, opened the paper, and thought that it was some white salt; she accordingly employed it for the boiler on the fire, and put it in the salt-cellars for the table. The master of the house had on that day company to dinner. Soup was served up, which proved to be bad, and the greatest part of the guests did not eat any; the meat

boiled in it appeared still more disagreeable; but two or three of the guests, pressed by hunger, thought to have covered the disagreeable taste of the meat by adding salt to it, and accordingly employed the muriate of tin which was in the salt-cellars: they swallowed several mouthfuls; but were soon obliged to abandon this dish on account of its insupportable flavour. The master of the house interrogated the cook: the source of the error was discovered, and milk and sugared water, was given to those who had swallowed any of the boiled meat: nevertheless, all the guests who had eaten a few spoonfuls of the soup, although they had made a good dinner afterwards, were seized with the colic: it was much the strongest in those who had eaten the boiled meat salted: in two individuals it continued two days, and was accompanied with diarrhæa. I think I recollect that none of the patients experienced any vomiting: copious mucilaginous drinks and glysters were sufficient to put an end to the symptoms.*

385. An austere, metallic, intolerable taste; a sensation of constriction in the throat, nausea, repeated vomitings; a sharp pain in the epigastric region, which in a short time extends to all the other regions of the abdomen; copious evacuations of the bowels, slight difficulty of breathing; pulse small, tight, and frequent; convulsive motions of the muscles of the extremities, and of the face; sometimes paralysis: these are the terrible symptoms to which the muriate of tin gives rise; they are mostly followed by death.

LESIONS OF TEXTURE PRODUCED BY THE MURIATE OF TIN INTRODUCED INTO THE STOMACH.

386. The lesions exhibited by this salt, greatly resemble those produced by the other corrosives, especially the deuto-

* Observation communicated by Dr. Guersent.

muriate of mercury. The mucous membrane of the stomach, and of the first portions of the small intestines, is commonly of a deep red colour, hard, contracted, tanned, difficult to remove, ulcerated in places; sometimes of a blood red. The muscular coat is frequently of a vermillion colour. I have likewise observed small black spots occasioned by the extravasation of venous blood between these two coats, which proceeded from the rupture of some small vessels in consequence of the violence of the inflammation.

It is needless to say, that it is impossible to discover, by the simple examination of these lesions, the nature of the poison taken into the stomach.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY MURIATE OF TIN.

387. If the patient is living, and the rest of the poison in a solid form can be procured, a small quantity should be dissolved in distilled water, and the solution examined, whether it present the characters we have detailed § 384; a portion of the solid salt should then be mixed with charcoal, and the whole should be heated in a crucible, with caustic potash *(Lapis infernalis);* the crucible should be covered with two or three pieces of charcoal, in order to prevent in some measure the volatilization of the muriate of tin: in the course of twenty, or five and twenty minutes, metallic tin, and muriate of potash, will be obtained, which may be separated by water (§ 383. M). If the poison be dissolved, after having treated it by the same re-agents, the remainder should be evaporated and calcined in the same manner.

388. If it be attempted to discover the poisonous substance in the matter vomited, it will be necessary likewise to begin with the tests described, § 384; and although all the menstrua should furnish precipitates such as we have described, it will

be indispensable, in order to pronounce with certainty, to extract from it the metallic tin, by drying the liquid, and calcining it in a crucible with potash.

389. When the poison, from having been rendered insoluble by its union with the alimentary matter, cannot be discovered in the fluids vomited; it will suffice as well, to dry and calcine the whole mass with potash: the presence of the revived metallic tin will leave no doubt of the existence of a preparation of tin.

The same steps as we have just pointed out are necessary to be taken in the case where the death of the patient allows of the fluids and solids contained in the digestive canal to be examined. In like manner the mucous membrane, and all the parts affected, should be submitted to calcination.

TREATMENT OF POISONING BY THE MURIATE OF TIN.

390. *Does there exist any antidote to the muriate of tin?*

In reflecting on the different substances which possess the faculty of suddenly decomposing the poison we are treating of, it appears to me that milk ought to unite the greatest number of advantages to oppose the destructive effects of this corrosive salt. I have consequently instituted a great number of experiments, which have been followed by the most complete success.

Experiment 1st. I caused a small dog to swallow nine drachms of the triple body in a solid form, obtained by precipitating the muriate of tin, by a sufficient quantity of milk.* The animal ate it with pleasure, and had only one vomiting at the end of ten hours; he recovered perfectly. It is certain that, had not the muriate of tin been strongly retained by the

* These nine drachms consisted of seven drachms of animal matter, and two drachms of muriatic acid and oxyde of tin.

animal matter, the dog would have been dead in the course of a few hours, even had he vomited several times.

Experiment 2nd. At eleven in the morning, an opening was made into the œsophagus of a middle-sized dog, into which a funnel was introduced, so as to allow of fluids passing into the stomach. Into this instrument were poured fifty-four grains of the muriate of tin, dissolved in two ounces of distilled water; and three minutes after, about fourteen ounces of milk were introduced, and the œsophagus was tied, in order to prevent vomiting.* The animal shewed no disposition to vomit; he did not even appear to suffer. The next day he was agitated, and tormented by a violent thirst; but walked well. He lived four days in this state, and his death was not preceded by any convulsive movements, or paralysis. On opening the body, no alteration was found in the mucous coat of the stomach, or intestinal canal.

This experiment proves that the milk prevented the action of the muriate of tin; for fifty-four grains of this salt introduced into the stomach of a dog whose œsophagus is tied up, destroy life in a few hours, exciting a considerable inflammation of the *primæ viæ*.

I wished to determine whether the milk acted as a diluent, or whether it exercised a chemical action similar to that which takes place in our laboratories.

Experiment. At thirty-nine minutes after nine, two dogs about the same size and weight were taken; the œsophagus of each was detached, and fifty-four grains of muriate of tin, dissolved in three drachms of distilled water, were injected into the stomach of each; immediately after, fourteen ounces of the same fluid were given to one of them, and fourteen ounces of milk to the other: the œsophagus of each was then tied. The first died the next day at five in the morning; the one which had taken the milk, lived five days, without

* This operation was extremely long.

experiencing any other symptom than a febrile action, and a degree of lassitude. The mucous membrane of the stomach of that dog, which had taken only water, was of a blood-red colour, principally in its pyloric portion; that which lines the duodenum, likewise presented some extremely red patches. There was not any alteration in the digestive canal of the animal, to which the milk had been given.

From this experiment it follows, that milk does not act by the water which it contains, but because it exerts on the muriate of tin, a chemical action which we have described, § 383. M.

391. Guided by these facts, the physician called to the assistance of persons poisoned by this salt, will have immediate recourse to milk in very great quantity; in case of a deficiency of this article, he will inundate the patients with broth, warm water, or sweet and mucilaginous decoctions: by these means the poison will be found diluted and decomposed, and will be soon expelled, on account of the fulness of the viscus, which contains it. In the cases where, in consequence of the rapid and energetic action of this poisonous substance, symptoms of inflammation of one or more of the organs of the abdominal cavity, should make their appearance, general and local bleedings will become necessary, with fomentations, and emollient and narcotic glysters. If the patient should fall a prey to alarming nervous symptoms, opiates and the least irritating antispasmodics should not be neglected.

Of the Oxyde of Tin.

392. I caused dogs of different sizes to swallow varied doses of the protoxyde and deutoxyde of tin; these animals experienced the same symptoms as those mentioned in the preceding article. The ingestion of one or two drachms of these substances, has constantly killed them, producing similar lesions to those occasioned by all the corrosives.

ARTICLE VI.

SPECIES VI.—PREPARATIONS OF ZINC.

Var. 1st. Sulphate of zinc.
2nd. Oxyde of zinc.

393. The preparations of zinc being much employed in medicine and in the arts, and their inconsiderate use being capable of occasioning serious accidents, we think it a duty to explain whatever relates to the kind of poisoning they may give rise to.

OF ZINC.

394. Zinc is a solid metal, of a bluish-white colour, and lamellated structure; its specific gravity is as 7,1.

395. When strongly heated in a crucible, it quickly goes into fusion: it absorbs all the oxygen of the atmosphere, and burns with a beautiful white flame inclining to green, and extremely brilliant. The oxyde of zinc formed, is diffused through the atmosphere, and is there condensed into extremely light flakes of a beautiful white colour. This oxyde formerly bore the names of *Flowers of Zinc, nihil album, lana philosophica,* etc. The metal may be extracted afresh, if collected, and calcined strongly with charcoal.

396. At the ordinary temperature, zinc dissolves with effervescence in the sulphuric and muriatic acids extremely diluted. A disengagement of hydrogen gas takes place, and the formation of a sulphate or muriate of zinc; which proves that the water has undergone decomposition.

397. Of late years it has been attempted to employ vessels of zinc for utensils intended for the preparation of food, and for measuring and preserving fluids: but the experiments of

M. M. Vauquelin and Deyeux, which we shall report, prove that this metal, which is easily acted upon, is attacked by water, vinegar, lemon juice, and sorrel, by the muriates of ammonia and soda, and by butter. Now as the compounds resulting from the action of some of these re-agents are possessed of purgative and emetic properties, it is prudent to replace this metal by those whose effects on the animal economy cannot be suspected.

" 1st. Water allowed to remain in vessels formed of zinc, " was partly decomposed, and a white oxyde was produced. " The water which covered this oxyde had a metallic taste.

" 2nd. A mixture of eight ounces of distilled water with " three drachms of distilled vinegar was boiled in a saucepan " of zinc: after eight minutes' ebullition, the liquor had ac- " quired a taste decidedly rough and metallic; it contained an " acetate of zinc, the presence of which was demonstrated by " the proper tests.

" 3d. A similar experiment was made with lemon juice " mixed in the proportion of three drachms to eight ounces " of water. The liquor after eight minutes of ebullition, " acquired a taste like the preceding; and it was discovered " by the tests, that it contained citrate of zinc.

" 4th. Eight ounces of water with an ounce of sorrel cut " fine, were boiled in a saucepan of this metal. The liquor " afterwards having been filtered, possessed no acid flavour: " it was even proved that it contained no metal in solution: " but small parcels of a whitish precipitate were observed, " which being collected and examined, exhibited the charac- " ters of oxalate of zinc.

" 5th. A mixture of eighteen grains of muriate of ammo- " nia and of twelve ounces of water, after eight minutes of " ebullition, yielded a liquor which contained zinc in solution, " the presence of which was demonstrated by the re-agents.

" 6th. The same experiment was repeated with the muriate " of soda, in the dose of a drachm and a half to twelve

" ounces of water; and a liquor was furnished, which, on " being treated with prussiate of potash, yielded a precipitate " of oxyde of zinc, but in small quantity.

" 7th. Lastly a composition was made with butter, flour, " &c. in a saucepan of zinc. At the end of the experiment, " it was found that the bottom of the vessel had lost its polish, " and that there was even formed, near the middle, a small " hole, through which the grease had oozed.

" It results from these experiments that zinc is acted upon " by water, the weakest vegetable acids, some saline sub- " stances, and butter. Now, since in the preparation of " food, vegetable acids are frequently employed, which are " capable of making this metal pass into the state of salt, it " may be readily conceived, that the salts of zinc producing " on the animal economy changes more or less sensible, this " metal should not be employed for utensils intended for the " preparation of food, or for the measuring and preserving of " fluids." *

* Annals of Chemistry, tom. lxxxvi. p. 51. Report made by M. M. Vauquelin and Deyeux.

M. M. Devaux and Dejaer, physicians at Liege, have tried a series of experiments on the human subject, relative to the use of the acetate and citrate of zinc. They have drawn the following conclusions from their experiments.

" 1st. That the acetate of zinc, in the dose in which it can be found in " food, and be swallowed without being aware of its presence, cannot " exert any action upon our organization.

" 2nd. That in a stronger dose it acquires an intolerable flavour, which " would constantly cause any aliment to be rejected, in which it might " chance to be found.

" 3d. That in a very strong dose, and such as it is impossible to obtain " in the preparation of any food, it has still no poisonous property; but " becomes a medicine of a disagreeable flavour, which possesses properties " emetic and slightly purgative, like the acidulated tartrate of potash, and " various other salts which are found combined in different aliments, and " which only come within the jurisdiction of medicine in a much higher " dose than is commonly employed in cookery.

" 4th. That the citrate of zinc, given in the dose of half a drachm, and

CHEMICAL HISTORY OF SULPHATE OF ZINC (WHITE VITRIOL).

398. The sulphate of zinc of commerce contains always sulphate of iron, and sometimes sulphate of copper. It is in the form of white masses, grained like sugar, often spotted with yellow. It has a pretty strong acrid, styptic, metallic taste; and is soluble in nearly twice and a half its weight of water, at 15°.

399. Thus dissolved it reddens the tincture of tournesol.

400. Potash and ammonia precipitate from it an oxyde of a greenish white colour, easily soluble in an excess of the latter of these alkalies. The oxyde obtained by potash, being washed, dried, and calcined with charcoal, is revived, provided the temperature be very much elevated.

401. The solution of sulphate of zinc of commerce furnishes, with prussiate of potash, a precipitate of a rather deep blue colour, consisting of prussiate of zinc and prussiate of iron. (Vide § 42.)

402. The hydro-sulphurets produce instantly a blackish sediment, consisting of hydro-sulphuret of zinc and hydro-sulphuret of iron.

403. The chromate of potash throws down from it chromate of zinc of an orange yellow colour.

404. Galls and a strong infusion of tea produce a deep violet blue precipitate.

" afterwards of a drachm, produced no effect of importance. (*Procès-ver-*
" *bal de la séance publique de la Société établie à Liege*, 1813."

If it be observed that M. M. Devaux and Dejaer made their experiments upon Spanish prisoners, of a good constitution and in good health; that they have never made them upon delicate persons, whose nervous systems are extremely irritable; and moreover, that they make no report of experiments on the use of saline solutions containing zinc, nor of that of butter loaded with the same metal, we ought to persist in not employing it until numerous and varied experiments have fixed our ideas in this respect.

405. Burgundy wine, and water saturated with sugar, occasion no turbidness in it.

406. Gelatine decomposes it, and produces a few light flakes of a yellowish white.

407. Albumine produces a white sediment.

408. Milk is curdled by a tolerably great quantity of this solution.

409. Human bile poured into the solution of sulphate of zinc, precipitates from it a few flakes of a yellow colour.*

ACTION OF SULPHATE OF ZINC ON THE ANIMAL ECONOMY.

410. The sulphate of zinc is, without dispute, of all the metallic salts, that which produces the fewest serious accidents. Being possessed of a high degree of emetic virtue, it is quickly expelled by vomiting, whenever introduced into the stomach. I might quote many cases in support of this fact, but shall confine myself to describing the two following experiments.

Experiment 1st. A small dog was caused to swallow sixty grains of sulphate of zinc in powder: five minutes afterwards he twice vomited some white matter. At the end of a quarter of an hour he made violent efforts to throw up a small quantity of a frothy substance, and refused to take any food. The next day he was quite recovered.

Experiment 2nd. To a middle-sized dog were given seven drachms thirty-six grains of sulphate of zinc of commerce, dissolved in two ounces of water: he experienced no inconvenience during the first twenty minutes; he then complained

* The sulphate of zinc freed from iron, and perfectly pure, gives a white precipitate to potash, ammonia, and the prussiate of potash; and a white, slightly yellow, to the hydro-sulphurets of potash, of soda, and of ammonia. The infusion of galls in alcohol does not produce any precipitate: the fluid, nevertheless, puts on rather a milky appearance.

a little, and vomited three times in the space of four minutes. The matter of the first vomiting was partly liquid and partly solid, and tolerably abundant: what he threw up latterly was mucous, stringy, and in small quantity: his moanings became more and more violent. Four hours afterwards the animal appeared fatigued; but he uttered no plaintive cries, and did no longer vomit. The next day he ate with a hearty appetite, and was quite recovered.

If, instead of leaving the animal the power of vomiting, the œsophagus be tied after introducing into the stomach a sufficient quantity of sulphate of zinc, or if this salt be injected into the veins, life is destroyed at the end of a time that is variable. What are the organs on which this substance exerts its action?

Experiment 1st. Forty-eight grains of sulphate of zinc dissolved in one drachm thirty-six grains of distilled water, were injected into the jugular vein of a small and weak dog. Scarcely had the liquid been injected, when the animal died without any other apparent symptoms than violent and fruitless efforts to vomit. The lungs presented no alteration: the mucous membrane of the stomach and intestines was in the natural state.

Experiment 2nd. Immediately after there were injected into the jugular vein of another small dog twenty-four grains of the same salt, dissolved in sixty grains of distilled water. A few seconds after the injection, the animal vomited a very small quantity of yellow liquid matter, stringy, and as it were bilious, and died in the space of three minutes, in such a state of tranquillity, that he might have been thought to have been asleep; his breathing was not at all impeded. On opening the body, the lungs and other organs were found in their natural state.

Experiment 3d. At half past eleven there were injected into the jugular vein of a strong middle-sized dog, twenty-eight grains of sulphate of zinc, dissolved in two drachms and a half

of distilled water: the animal instantly made great efforts to vomit, and threw up only a very small quantity of froth: for five minutes he was in such a state of stupor and inactivity, that he fell on his side, and when set up on his feet instantly fell again like an inert mass of matter. His breathing was deep and a little difficult, without being accelerated. At the end of this time he appeared to recover the use of his senses; he was lifted up and walked with tolerable facility: his breathing became more and more accelerated and short, to such a degree that *a hundred* inspirations might be counted in a minute. A quarter of an hour after the injection, he lay down again without uttering the least plaintive cry; he was not agitated by any convulsive movement, his whole body was tranquil; he was set up again on his feet, and the slightest blow was sufficient to upset him. At one o'clock his situation appeared very satisfactory, he seemed not to have experienced any indisposition. The next day, at two in the afternoon, his breathing was a little difficult; he continually uttered cries not very acute: when approached he made frightful howlings: there were neither convulsions nor paralysis. Two days afterwards, judging him to be perfectly recovered, food was given to him, and he devoured a great quantity of victuals. He was kept till the eighth day without experiencing the slightest accident.*

Experiment 4th. The œsophagus of a strong shaggy dog was detached, and an opening made in it, through which were introduced, by means of an elastic gum catheter, seven drachms thirty-six grains of sulphate of zinc, dissolved in two ounces and a half of water: the œsophagus was tied below the opening. At the end of ten minutes the animal made fruitless efforts to vomit; he passed two liquid stools, in which he expelled a worm. Four hours after, his breathing was a little

* A few days afterwards, this dog was killed by making him swallow another poisonous substance. He was dissected, and the lungs were found to be sound.

difficult. The next day he appeared fatigued, inactive, and moaned from time to time. He died on the night of the third day.

Appearances on Dissection.—The mucous membrane of the stomach was of a deep red colour throughout its whole extent; it shewed here and there black spots formed by extravasated blood upon the muscular coat. The duodenum and other intestines exhibited no remarkable alteration. The lungs were rather less crepitating than in their natural state, and their colour was rather dark.

The three first experiments seem to prove that a concentrated solution of the sulphate of zinc introduced into the veins, acts by stupifying the brain. In the third, this salt appeared likewise to exert its action upon the lungs. Nevertheless the quick recovery of the animal, and the natural state in which the thoracic viscera were found, would tend to create a belief that the pulmonic symptoms were purely symptomatic of the nervous affection under which the animal would undoubtedly have sunk, had he not been sufficiently strong to resist the first attack of the poison. In the last experiment, death ought to be attributed both to the action of the sulphate of zinc on the stomach, and to the operation to which the animal had been submitted.

SYMPTOMS OF POISONING BY SULPHATE OF ZINC.

OBSERVATION 1st.

"A young lady, pressed by ardent thirst, drank off at a "draught half a *setier* of a liquor which she took for lemon-"ade, and which unfortunately proved to be a solution of "two ounces of white vitriol: she only found out her error at "the last mouthful, which she threw away.

"An excessively astringent taste was perceived, and her

" throat appeared contracted to such a degree as to cause an " apprehension of strangulation. Recourse was instantly had " to milk and oil, both alike nearly useless in a case like this.

" On my arrival, I found the lady in a dreadful situation, " her countenance pale and sunk, the extremities cold, the " eyes dim, and the pulse convulsive. Being informed of the " cause of the accident, I hastened to procure the remedies " which I considered the most effective. Knowing that white " vitriol was, before the discovery of tartarized antimony and " ipecacuanha, the emetic most commonly employed by the " ancients, I informed her that it would soon act as such. In " short, vomiting soon took place; and I kept it up by giving " warm water.

" Being certain that this method had caused the evacuation " of a great part of the poison, I set about decomposing the " rest by means of the fixed alkali diluted with sugared water. " From that moment the vomiting quickly ceased. The burn- " ing heat which the lady experienced at the stomach subsided " by degrees, and in less than two hours yielded entirely to the " use of the alkaline solution. I ordered her to use a gargle " of a little more concentrated solution of alkali, in order to " decompose the vitriolic particles adhering to the throat and " mouth, and which continued to act upon those organs.

" The pulse being perfectly restored, I recommended, for " the rest of the day, milk, broth, and linseed tea. I ordered " likewise the employment of glysters and warm baths, in " order to calm the degree of heat, which had now extended " itself to the extremities, as well as the irritation of the ner- " vous system." *

OBSERVATION 2nd.

A baker of Fribourg, convalescent from putrid fever, being

* This observation is from the collection of Parmentier. Vide Buchan *Médecine Domestique*, tom. iii. p. 150, 3d edition.

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tormented by an ardent thirst, swallowed eight or ten ounces of water in which his servant had put, by mistake, some white vitriol, (sulphate of zinc). A few minutes after, the baker complained of pains in the epigastric region, and afterwards over the whole of the abdomen; in a short time he was seized with vomitings and continual stools: he had recourse alternately to butter and cream, the effects of which he had heard extolled in similar cases: all these greasy substances, which he vomited as fast as he swallowed them, gave no relief.

This poison had been about an hour in his stomach when I was called in. On arriving at his house I perceived the remains of the vitriol at the bottom of the glass, which had not been dissolved: I caused him to take as much as he could swallow of prepared crabs' eyes, and afterwards a tea-spoonful at a time, at intervals, in such a manner that he took in the whole an ounce.

The first dose of this remedy excited in an instant an effervescence which changed the pain of the stomach into a burning heat, and produced eructations, the taste of which the patient could never determine, bordering however on sour. This symptom was only temporary, and in less than an hour the whole of the symptoms which had appeared from the beginning, vanished.

The patient, however, felt some putrid eructations from the stomach, and from time to time made slight efforts to vomit: at length the thirst too returned again.

A few drops of dulcified spirit of nitre, which I directed to be taken in water, with a view to saturate the excess of crabs' eyes, of which the patient had, without doubt, taken more than was necessary for absorbing the vitriolic acid, relieved effectually these new symptoms. At four in the afternoon, the patient, who had regained his appetite, and eaten a little broth, returned, perfectly cured, to his bakehouse.*

* Journal de Médecine, Chirurg. et Pharm. tom. lvi. ann. 1781, p. 22. Observation de M. Schueler.

OBSERVATION 3d.

"I attended," says M. Fodéré, "an officer of the customs to whom an apothecary had given internally sixteen "grains of this salt, for the cure of a gonorrhœa, who was "labouring under symptoms of poison, particularly inflammation of the abdomen, with retraction of the navel, and "colics similar to the *miserere*, which did not give way without repeated, general, and local bleedings, copious emollient drinks continued for the course of a month; oily medicines, opiates, and warm baths repeated every day.*

411. An astringent taste, sense of strangulation, nausea, copious vomitings, frequent stools, pains in the epigastric region, extending afterwards over the whole of the abdomen, difficulty of breathing, frequency of pulse, paleness of the countenance, and coldness of the extremities; such are the symptoms which the saline substance we are describing gives rise to.

LESIONS OF TEXTURE PRODUCED BY SULPHATE OF ZINC.

412. It will be readily conceived, that the derangements produced by this salt cannot be very considerable, if it be remembered how confined its corrosive properties are. Neither do we find after the death of animals which have fallen victims to very strong doses of the sulphate of zinc (their œsophagus having been tied) any thing more than an inflammation, not very severe, of the membrane with which it had come in immediate contact: sometimes some black blood is observed to be extravasated upon the muscular coat of the stomach and intestines.

* Fodéré, Op. Citat. p. 165, tom. iv. 1813. It would be difficult to produce a case in which so small a dose of sulphate of zinc has caused such severe symptoms.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY SULPHATE OF ZINC.

413. The practitioner called upon to determine a case of poisoning produced by this salt, will act according to the chemical rules laid down § 401 to 409. If the poisonous substance has not been wholly swallowed, he will submit it to the action of the tests which are capable of recognising it: in such cases where the salt is to be sought for in the matter vomited, or in that contained in the digestive canal, the analysis of this matter by the same menstrua, and above all the reduction of the sulphate of zinc to the metallic state, are the only means capable of enabling him to decide with certainty. This reduction, which is difficult to effect, will always take place by heating to redness in a crucible, strongly, and for a long time, the masses of the salt evaporated, dried, and mixed with caustic potash. Vide § 400.

TREATMENT OF POISONING PRODUCED BY SULPHATE OF ZINC.

414. The physician called in to the assistance of persons who have swallowed too strong a dose of sulphate of zinc, should always keep in view, how strong an emetic property it possesses; he will consequently endeavour to promote the vomiting, by giving to the patient a great quantity of warm water and emollient drinks, amongst which the preference should be given to *milk*, which possesses likewise the power of effecting the decomposition of the saline substance: this animal fluid ought to be preferred to alkaline solutions, which are generally of too irritating a nature. Emollient glysters frequently repeated, will also give great relief, especially when the poison has passed the pylorus and is found in the intestinal canal. General bleedings, leeches, and warm baths, are the means

which should be had recourse to when inflammation of the abdomen is threatened, or when it shall have already appeared. If the patient should be endued with an excessive degree of nervous irritability, and be attacked with obstinate vomitings, so that there should be reason to believe that the whole of the poison has been expelled, this alarming symptom alone should then be attended to, and opiates administered without delay.

OF THE OXYDE OF ZINC.

415. The oxyde of zinc is white, extremely light, and soft to the touch; it easily dissolves in sulphuric acid, and gives rise to the sulphate of which we have just been giving the chemical history: these characters, added to those we have before described in speaking of metallic zinc, are sufficient for recognising it. I have given this oxyde to small and weak dogs, in the dose of from three to six drachms. They were attacked with vomitings, without suffering much; and their health was soon completely re-established.

ARTICLE VII.

SPECIES VII.—PREPARATIONS OF SILVER.

VAR. *Nitrate of Silver.*

416. The nitrate of silver is a powerful corrosive poison; we are of opinion that the attention of physicians should be called to a substance employed for a long time past as a hydragogue cathartic, and which is at this day recommended by able practitioners for the cure of epilepsy.

OF SILVER.

417. Silver is solid, of a beautiful white colour, extremely

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brilliant. Its ductility is very great. Its specific gravity is as 10,4743.

418. Silver exposed to the action of caloric, goes into fusion at a little above a cherry-red heat.

419. Oxygen is capable of combining with this metal, and gives rise to an oxyde of a deep olive green colour, which is decomposed by the simple action of heat.

420. Sulphur combined with silver forms a black sulphuret.

421. Nitric acid diluted with about an equal weight of water dissolves silver by the assistance of a gentle heat. Nitrous gas is formed (deut-oxyde of azote) which partly remains at liberty in the acid, and colours it green, and is partly disengaged, diffusing in the air vapours of an orange-yellow colour.

Rationale. (Vide § 290. Part I. p. 200.)

We shall next examine the properties of nitrate of silver. Pure silver is not poisonous.

CHEMICAL HISTORY OF THE NITRATE OF SILVER.

422. This salt crystallizes in thin plates, very broad, of a beautiful white colour, the forms of which are extremely various. Its taste is bitter, acrid, and very caustic.

423. When thrown on burning charcoal, it enlivens its combustion, swells, puffs up, and goes into decomposition, with a disengagement of vapours of nitrous acid gas of an orange-yellow colour: the metallic silver remains upon the charcoal with all its usual lustre.

424. Water at 15°. dissolves about its own weight of it. The solution is colourless, and stains the skin of a violet colour.

425. Muriatic acid and the soluble muriates decompose it, and precipitate the corneous muriate of silver, of which the peculiar characters have been given, § 40.

426. Potash, soda, and lime-water produce a precipitate

of the oxyde of silver of a deep brown: whilst the nitric acid is united to the base employed.

427. It is not disturbed by ammonia, which depends upon the solubility of the ammoniacal nitrate of silver thus formed.

428. The hydro-sulphurets produce in the solution a sediment of black sulphuret of silver. *Rationale.* (Vide § 315.)

429. Chromic acid, and chromate of potash, precipitate from it a chromate of silver of a beautiful carmine red, which changes to a purple on being exposed to the light.

430. Arsenious acid, and the soluble arsenites, precipitate a yellow arsenite of silver, the colour of which becomes black when exposed to the air.

431. The solution nitrate of silver yields a precipitate of phosphate of silver of a yellow colour, on the addition of a few drops of phosphate of soda.

432. Phosphorus put into this solution decomposes it, passes into the state of phosphoreous or phosphoric acid, and the metal is precipitated. *Rationale.* (Vide § 316.) A plate of copper produces the same decomposition, with this slight difference, that no phosphoreous or phosphoric acid is formed, and that the fluid becomes blue in proportion as the action takes place, which phenomenon depends upon the formation of nitrate of copper. The metal precipitated is composed of silver and a small quantity of copper.

Rationale. (Vide § 44.)

433. Prussiate of potash forms a white precipitate with nitrate of silver.

434. The solution of galls in alcohol occasions no sensible change.

435. If ten parts of Burgundy wine be added to one part of the solution of nitrate of silver, the fluids become slightly turbid, and acquire a violet colour. Muriatic acid gives with them a white precipitate, but which will soon assume a rose colour in the air. The hydro-sulphurets produce a greenish

brown precipitate; and lastly the phosphate of soda precipitates them of a violet blue, whilst the nitrate of silver unmixed, gives a yellow precipitate with this same re-agent.

436. If fifteen parts of an infusion of tea be added to two parts of the solution of nitrate of silver, there will be obtained in the course of three or four minutes a flaky precipitate of a deep purple red, bordering a little on black. If only one part of nitrate of silver be employed, the mixture, which is of a yellow colour, passes first to a red, then to a black, without any alteration of its transparency: in this state, the muriatic acid produces a sediment, yellow and curdled.

437. Albumine precipitates copiously the nitrate of silver; the precipitate appears in the form of heavy coagula of a white colour, and it easily dissolves in an excess of albumine.

438. Gelatine produces no change in the solution of nitrate of silver.

439. A mixture made with nine-tenths of broth, and one tenth of nitrate of silver, furnishes immediately a yellowish white precipitate, very heavy.

440. Milk is coagulated by the nitrate of silver when employed in sufficient quantity: a formation takes place of very small white curds, and the fluid becomes transparent.

441. Bile, poured into the solution of nitrate of silver, produces an orange-yellow precipitate, the colour of which is not changed by the addition of a fresh quantity of bile.

OF THE LAPIS INFERNALIS (LUNAR CAUSTIC).

Lunar caustic is nothing else than the neutral nitrate of silver cast.

442. It is usually seen in the shape of small cylinders of a blackish brown outside, presenting radiated lines on their fracture.

443. When placed on burning charcoal, it causes it to burn with greater intensity (a character belonging to all the nitrates) swells, bubbles up, becomes decomposed, and leaves metallic silver easy to be known, especially when rubbed with a hard body in order to make it acquire its peculiar lustre and brilliancy.

444. Distilled water dissolves lunar caustic at the ordinary temperature, and the solution possesses the same properties as that obtained by the crystallized nitrate of silver. In fact, it gives a white precipitate to the muriatic acid, a deep brown to potash and lime, a black to the hydro-sulphurets, red to the chromic acid, and yellow to the arsenious acid. Ammonia does not at all disturb it, and copper and phosphorus separate from it metallic silver.

ACTION OF THE NITRATE OF SILVER ON THE ANIMAL ECONOMY.

445. When injected into the veins, this salt gives rise to the most alarming symptoms, even when employed in a very small dose; it almost always occasions death; its action is much less powerful when introduced into the stomach. What are the organs which first receive so fatal an impression? I have undertaken a series of experiments in order to throw some light upon this question.

Experiment 1st. At thirty-five minutes after eleven o'clock, one third of a grain of nitrate of silver dissolved in two drachms of distilled water, was injected into the jugular vein of a strong dog, though of small size. At the end of half an hour, his respiration became difficult and sonorous; the animal appeared to be suffocated; a quarter of an hour after he was calm; he made a few steps without exhibiting the least sign of vertigo or paralysis. He was scarcely laid down ten minutes, when he had fresh attacks of suffocation; his breath-

ing was extremely frequent and difficult, and the left fore leg was agitated with slight convulsive movements. We wished to know if he could still stand on his legs; he made a few steps without staggering, but he had fresh attacks of suffocation; the convulsive motions continued in the same limb, and became stronger and stronger. At three o'clock he could no longer walk; his breathing was excessively accelerated and difficult; his moans and horrible cries announced the pain which he suffered; he had now and then shocks, during which all the muscles were strongly contracted; the upper lip was agitated with convulsive motions. He died at six minutes after four.

Appearances on Dissection.—Several portions of the lobes of the lungs were livid, of a compact texture like liver, not at all crepitating when cut or pressed; they did not float in water: other portions were of a rose colour, crepitating, and lighter than this fluid. The mucous membrane of the duodenum was of a very bright cherry red, and was easily detached: the other portions of the intestinal canal did not present any remarkable change.

Experiment 2nd. Two grains of nitrate of silver dissolved in three drachms of distilled water, were injected into the jugular vein of a small dog: immediately panting, choaking, and suffocation came on, with vertigo. These symptoms went on increasing: at the end of two minutes, great efforts to vomit, some slight convulsive movements of the right fore paw; the mouth, lips, and tongue were livid; a great quantity of bloody serosity flowed through the left nostril: the animal was ready to expire. We wished to know whether the blood contained in the arteries was black; the crural artery was opened; and about an ounce of red blood flowed out, when all at once the bleeding stopped. It was about four minutes from the injection: the arterial opening was examined, and was found to be stopped up by a coagulum of blood of a clear red colour: this was removed, and a small quantity of blood followed of a

blackish red. The animal made fresh but unsuccessful efforts to vomit. He died six minutes after the injection.

Appearances on Dissection.—This was immediately performed. The muscles contracted by the simple contact of the air: the heart was of a livid hue bordering on black, and was swelled out by a very great quantity of blood; that contained in the left ventricle was black; the right auricle alone contracted slightly: the arteries of this organ were empty; the descending aorta was of a small diameter. The lungs, throughout almost their whole extent, exhibited a deep rose colour; the posterior lobe, which was of a red colour, inclining to black, contained a great quantity of black blood.

Experiment 3rd. Three quarters of a grain of nitrate of silver, dissolved in a drachm and half of water, was injected into the jugular vein of a middle-sized dog: two minutes afterwards the animal was affected with vertigoes and syncope: his breathing became difficult; he opened his mouth wide, and tried to force the introduction of air into the lungs by deep inspirations; he could not walk without falling upon his head. These symptoms increased in violence till the moment of his death, which took place ten minutes after the injection. Two minutes before he expired, the right crural artery was opened: the blood which flowed from it was black. The body was opened immediately after death: the lungs exhibited black spots in several points of their posterior part; all these points were less crepitating than the rest, and they were filled with serosity, and a little blood. The heart did not contract in any part of it; the left ventricle contained black blood; the stomach, which was in its natural state, contained a great quantity of food.

Experiment 4th. Half a grain of nitrate of silver dissolved in fifty grains of distilled water, were injected into the jugular vein of a small terrier dog: in an instant the animal experienced a great degree of uneasiness and agitation: at the end of two minutes he was seized with vertigo, anhelation, and

suffocation: he vomited a little white matter floating in a great quantity of foam, and had an involuntary excretion of urine. Five minutes after the injection he was agitated with convulsive movements of the thoracic muscles, and especially of those of the abdomen. He died eleven minutes after the injection. The lungs were filled with blood and exhibited towards their posterior part, some patches of a deep red, the texture of which was less crepitating than in their natural state.

Should we not conclude from these experiments, that a very small quantity of the nitrate of silver, introduced into the torrent of the circulation, immediately destroys life, by acting upon the lungs and on the nervous system?

Experiment 5th. The œsophagus of a strong shaggy dog was detached, and an opening made in it: twelve grains of nitrate of silver in a solid form, enveloped in a paper cone, were introduced into the stomach, and the œsophagus was tied below the opening to prevent vomiting. The animal died on the night of the sixth day, without having experienced any other symptoms, than debility, intense thirst, and frequency of pulse. The mucous membrane of the stomach was not very red, all that portion near the pylorus exhibited small black spots, the size of pins' heads, so as to appear dotted. An attentive examination shewed that these spots were portions of the mucous membrane scarified, being absolute perforations, which did not at all affect the muscular coat. A few of these scars were likewise found in some other parts of this membrane. The lungs were perfectly sound.

Experiment 6th. At five minutes after twelve at noon, a robust dog of the middle size, was made to swallow twenty grains of the nitrate of silver dissolved in seven drachms of distilled water; ten minutes after, the animal uttered plaintive moans. At two o'clock he had not vomited, he continued to whine, and was extremely dejected: in the evening he did not appear to be much deranged. The next day he ate with some

appetite. The third day at eleven in the morning he was made to swallow thirty-two grains of the same salt dissolved in seven drachms of distilled water: two minutes afterwards he vomited a great quantity of a pulpy matter, mucous and stringy, amongst which could easily be distinguished part of the food he had taken the evening before. These vomitings were repeated five times in the course of the first forty-two minutes from the ingestion of the salt: his respiration was no way difficult, and he made no complaint. The next day, (being the fourth from the first experiment) he ate a tolerable quantity of food. On the fifth day, his œsophagus was detached and perforated, and thirty-six grains of nitrate of silver dissolved in four drachms of distilled water were introduced through the opening. He immediately after appeared to be suffering excruciating pain, and continued to utter plaintive moans during two hours; he breathed easily; he experienced neither convulsions nor paralysis, and was able to walk about freely. At three o'clock he ceased to moan, and fell into a state of extreme dejection. The day after, being the sixth day, he was in the same condition, and died during the night.

Appearances on Dissection.—The mucous membrane of the stomach was reduced to such a state, as to resemble, in some measure, boiled meat almost liquid, and could be detached with the greatest facility. Near the pylorus were seen some eschars of a grayish white appearance, similar in every respect to those produced by the lunar caustic applied to external wounds. The muscular coat, which was of a cherry red, was evidently inflamed in several places, in others it was worn very thin. The lungs were red, rather livid, crepitating, and contained a quantity of air in every part; they contained but a very small quantity of blood; their texture was neither dense nor hepatized, and they floated in water.

446. If we consider with what facility the smallest quantity of nitrate of silver introduced into the circulation, occasions death, by acting upon the lungs, we shall be obliged to con-

clude that this salt cannot have been absorbed in the two last experiments: the death of the animal would have quickly followed, and the symptoms would have been similar to those observed when the salt is injected into the veins. We are of opinion, then, that the nitrate of silver, when introduced into the stomach, induces death by corroding the texture where it may come into contact, and by producing an inflammation more or less considerable. It is probable that if, instead of exhibiting thirty-six grains of this salt, three or four drachms had been employed, life would have been destroyed in a few hours: the stomach in that case, being strongly irritated and inflamed, would have produced a re-action upon the brain, by means of the numerous nervous ramifications which connect those two organs.

SYMPTOMS OF POISONING PRODUCED BY NITRATE OF SILVER.

447. Boerhaave relates, that a student in pharmacy swallowed some lunar caustic, and serious symptoms resulted from it: excruciating pains, gangrene, and sphacelus of the first passages, were the speedy effects of this poison.

The nitrate of silver exhibits the same symptoms as those of which we have already given account several times, when speaking of *corrosives:* for which reason we shall confine ourselves to this simple description. It may sometimes happen that the borders of the lips and the space round the chin be covered with purple spots, particularly when this salt has been taken in a fluid state. It is, moreover very probable, that in this kind of poisoning, the mucous membrane which lines the inside of the mouth may sometimes present eschars of a grayish white, similar to those produced by a cylinder of lunar caustic on a wound.

LESIONS OF TEXTURE PRODUCED BY THE INGESTION OF NITRATE OF SILVER.

448. When the action of this salt has not been sufficiently powerful to reduce the mucous membrane of the stomach to a state like boiled meat, a redness of this membrane is perceived, more or less intense, and more or less general: several points of its texture are, as it were, scarified, and the colour of the eschars is of a grayish white, or of a very deep black. This remarkable change takes place principally when the nitrate of silver has been taken in a solid form. If the mucous membrane be destroyed, the muscular coat of the stomach is found very much inflamed, of a bright red colour, and scarified in various places; sometimes its action has been carried to such a length as that one or several perforations are perceived. It is easy to conceive, that the œsophagus, the pharynx, and the inside of the mouth, may, under certain circumstances, be the seat of similar morbid alterations.

APPLICATION OF ALL THAT HAS BEEN SAID, TO THE DIFFERENT CASES OF POISONING BY NITRATE OF SILVER.

449. The physical and chemical characters detailed in § 422 and seq. will do away the necessity of our repeating here the methods of ascertaining this poison when it is without mixture, and the practitioner has a portion of it at his disposal.

450. If it should be necessary to discover the nitrate of silver amongst the fluids vomited, or those contained in the stomach of a person deceased, they must be filtered and essayed by the re-agents proper for discovering this salt, paying attention always to the changes of colour which the different kinds of aliments and drinks may produce in the precipi-

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tates. (Vide Part 1st p. 113. Note.) This first examination being terminated, the fluids should be evaporated and calcined, to obtain the metallic silver.

451. If these trials should prove insufficient, the poison must be sought for in the solid matter vomited, in the parts that have been scarified, and, lastly, in the alimentary matter contained in the stomach. By desiccation and calcination of these substances, the metallic silver will be easily separated, the characters of which we have described § 417 et seq.

TREATMENT OF POISONING BY NITRATE OF SILVER.

452. Is there any antidote to the nitrate of silver?—I have attempted to resolve this problem by submitting a number of animals poisoned by this salt, to the action of certain chemical tests.

Experiment 1st. The œsophagus of a small dog was detached and perforated; thirty-six grains of the nitrate of silver dissolved in an ounce of distilled water were introduced into the stomach, being previously mixed with two drachms of muriate of soda dissolved in two ounces of water: the œsophagus was then tied below the opening to prevent vomiting. An hour afterwards the animal appeared a little dejected, and made slight efforts to vomit. He died at the end of the fourth day without showing any other symptoms than dejection.

Appearances on Dissection.—The mucous membrane of the digestive canal was in its natural state,* and *presented no eschar.*

Another animal was submitted to the same experiment, excepting that the two fluids were introduced into the stomach

* It was of a clear red colour in some places; but this colour is natural to the mucous membranes of the stomach of dogs, as any one may convince himself by opening one of these animals alive.

separately, and one immediately after the other. Death supervened on the fifth day, without discovering the smallest eschar either in the stomach or intestines.

We do not hesitate to conclude from these facts, that muriate of soda dissolved in water "is an antidote to the nitrate of silver; it is in truth necessary that it be administered a very short time after the ingestion of the poisonous substance, the rapid action of which gives rise to lesions, which when once produced, can by no means be cured by the salt which we recommend.*

* If we reflect on the energy with which muriate of soda transforms nitrate of silver into an insoluble muriate, possessing no power of acting on the animal economy, it will be perceived how advantageous it is to employ the substance which we propose.

It may be objected that the two animals to whom the muriate of soda was exhibited, lived a shorter time than the two others who did not take that salt, and were in other respects placed in the same situation, (vide § 445, exp. 5th and 6th.) Before answering to this objection, we shall propose some general remarks on the antidotes of corrosive substances, which will be sufficient to resolve it in a very satisfactory manner.

1st. It is impossible to affirm that any chemical agent is the antidote to a metallic corrosive poison, unless the animals submitted to the experiment be prevented from vomiting. In fact, the recovery of the animal may depend on the expulsion of the corrosive substance upon which the chemical agent has exerted no influence. These kinds of experiments then can have no weight, except in those cases where the œsophagus is tied up.

2nd. The degree of vitality of animals varies in an astonishing manner. I can confidently affirm, from a great number of facts: *a.* that an animal whose œsophagus has been tied, and that has taken no poisonous substance, lives sometimes two days less than another of the same species and size, that has been made to swallow some poison, and that, in other respects, is placed under the same circumstances: *b.* that death happens frequently two or three days later in one animal that has swallowed some poisonous substance in the same dose as another animal of the same species, the œsophagus of each being tied. It is then impossible to draw any strict conclusion by paying regard only to the number of days that may elapse between the poisoning of the animal and its death. We must however except some poisons of this class, such as corrosive sublimate and the con-

453. The physician called in to the assistance of persons who may be poisoned by this salt, should have recourse then to copious draughts of water, slightly salted, without being at all afraid of the developement of heat, which might be the consequence of the administration of this medicine. The advantages resulting from neutralizing the deleterious salt by efficacious means do not allow of hesitation in so urgent a case. Emollient, mucilaginous, and sweet drinks may be afterwards employed to calm the irritation produced by the poison. In those cases where inflammation of the abdomen is indicated by the symptoms which characterize it; general and local bleedings, warm baths, emollient fomentations, and glysters must be had recourse to.

centrated acids, the action of which substances is so powerful and constant, that they always occasion death in the course of a few hours. Let any one, for example, introduce into the stomach of one dog a drachm of corrosive sublimate dissolved in eight ounces of water, and into that of another dog of the same size a like quantity of this salt mixed with six ounces of the same liquid, which shall have been previously diluted with the albumine resulting from the whites of seven or eight eggs; the former will die inevitably in the course of a few hours; the second will live two or three days, the œsophagus of each of these animals having been tied.

3d. When it is proved that such a corrosive poison produces inflammation, ulceration, and scarification of one or of several parts of the digestive canal, we ought, without hesitation, to pronounce that chemical agent to be its antidote, which prevents it from producing all these injuries, whatever may be the time at which death may supervene.

ARTICLE VIII.

SPECIES VIII.—PREPARATIONS OF GOLD.

VAR. 1. *Muriate of Gold.*
2. *Fulminating Gold.*

454. Gold, which has been long banished from the materia medica, possesses, when dissolved in the muriatic acid, properties extremely energetic, which might render it a medicine of great utility in certain syphilitic affections; for which reasons the practitioners of our days do not hesitate to employ it in such affections, taking always the necessary precautions to prevent danger. The symptoms which result from the introduction of a ninth of a grain of the muriate of gold into the stomach, induced me to conjecture that it was possessed of mischievous qualities, and experience has not failed to convince me that it may be justly ranked amongst the poisonous substances. I shall prefix to its chemical history some ideas on the metal which enters into its composition.

OF GOLD.

455. Gold is a solid metal; of a very brilliant yellow colour, the most ductile, and the most malleable of all bodies; its specific gravity is as 19,257.

456. When exposed to the action of caloric in the open air, it fuses only above a red heat, without absorbing the smallest quantity possible of oxygen: there are, however, two oxydes of gold of a brown colour capable of being decomposed by the simple action of heat or of light, and of yielding the pure metal.

457. Among the acids, the nitro-muriatic (aqua regia) alone possesses the power of effecting the solution of it in a manner

prompt and complete; the deuto-muriate of gold obtained is of a yellow colour, so much the deeper as it is less diluted with water. In this operation the gold is oxydated by a part of the oxygen of the nitric acid, and the oxyde is dissolved by the muriatic acid.

458. *Chlorine*, (oxygenated muriatic gas) is capable, at the ordinary temperature, of dissolving gold, when allowed to pass bubble by bubble into a flask containing water, at the bottom of which are placed extremely thin leaves of this metal.

459. The deut-oxyde of gold is soluble in ammonia, giving rise to the fulminating gold.

In its metallic state, gold possesses no poisonous property.

CHEMICAL HISTORY OF THE DEUTO-MURIATE OF GOLD.

460. The deuto-muriate of gold crystallizes in needles of a deep yellow colour, and of a strong styptic taste.

461. When thrown on burning charcoal, it becomes decomposed, and converted into metallic gold, muriatic acid gas (hydro-muriatic gas), and oxygenated muriatic gas (chlorine).

462. It strongly attracts the moisture of the atmosphere, and dissolves very well in water. The solution, which is of a yellow colour, variable, reddens the tincture of tournesol, and stains the skin purple.

463. Ammonia precipitates from it yellow reddish flakes, (the colour of Spanish snuff) when used in small quantity; an excess of alkali changes this colour into a canary yellow; the flakes thus obtained, being washed and dried in a gentle heat, constitute fulminating gold, composed of the deut-oxyde of gold and ammonia.

464. Potash poured into a solution of muriate of gold not very acid, forms in it a brownish red precipitate of deut-

oxyde, provided that a sufficient quantity be employed, and the liquor be heated.

465. Prussiate of potash creates no disturbance in this solution, although almost all the other metallic salts are precipitated by this re-agent.

466. The hydro-sulphurets of potash, soda, and ammonia, form a sediment of sulphuret of gold of a deep chocolate colour.

467. The proto-sulphate of iron (sulphate of iron at minimum) poured into the solution of deuto-muriate of gold, precipitates it instantly of a brown colour, and there are seen floating on the surface of the fluid, pellicles of gold excessively thin. The precipitate, which consists of metallic gold, puts on all its lustre on being rubbed. There remains in the liquor a deuto or trito-sulphate of iron.

Rationale. The gold, having little affinity for oxygen, yields to the prot-oxyde of iron that with which it is combined in the deuto-muriate; after which, as it can no longer be held in solution, it subsides.

468. The proto-muriate of tin (muriate of tin at minimum) brought in contact with this salt, decomposes it, lays hold of a part of the oxygen contained in the deut-oxyde of gold, and passes into the state of deuto-muriate of tin; then the prot-oxyde of gold resulting from this action is precipitated with a portion of the oxyde of tin, and shews itself of a purple colour, or reddish purple, or violet purple, according as the solutions are more or less concentrated, or more or less acid, and as they may be employed in greater or smaller quantity.*

469. The nitrate of silver decomposes the deuto-muriate of gold, and precipitates from it muriate of silver of a reddish colour, which is probably owing to the oxyde of gold which

* M. Proust is of opinion that the gold is found here in its metallic state.

it partly draws down with it. Ammonia brought in contact with this precipitate, dissolves the whole of the muriate of silver, and leaves the oxyde of gold of a canary yellow.

470. Sugared water effects no change in the solution of gold.

471. Infusion of tea precipitates it of a reddish yellow colour.

472. The infusion of galls in alcohol causes it to pass into a red colour, and at the end of a few seconds, throws down an insoluble body of a chocolate colour, and pellicles of gold extremely thin may be observed floating on its surface.

473. A few drops of this solution mixed with Burgundy wine, throws down a precipitate of a beautiful deep purple, and the surface of the fluid likewise presents pellicles, of a yellow colour, formed of metallic gold.

474. Albumine produces in it a flaky precipitate in great abundance and of a yellow colour.

475. Gelatine immediately throws down yellowish filaments, which are long, and interwoven in such a manner, as to imitate a vegetable ramification.

476. Milk is instantly coagulated in large curds, which are precipitated.

477. Human bile, poured into a great quantity of deuto-muriate of gold, gives rise to a flaky precipitate of a green colour, which passes shortly into purple: if the quantity of bile be increased, it becomes of a beautiful violet.

ACTION OF THE DEUTO-MURIATE OF GOLD UPON THE ANIMAL ECONOMY.

478. M. Chretien, in a work entitled, *Methode Iatraleptique* asserts "that the muriate of gold is infinitely more ac-"tive than corrosive sublimate, but that it is less irritating to "the gums; administered in the dose of a tenth part of a "grain daily, it occasioned in one instance a strong fever.

" The excitement produced by this salt, if restrained within " due bounds, is never accompanied with any notable or even " sensible lesion of the functions. The mouth is in a proper " state, the tongue moist; the appetite does not fail, nor do " the alvine discharges undergo any derangement; there is " generally only an increase of the urine, or perspiration; but " in pushing the dose too far, there is a risk of producing a " general irritation of the system, inflammation of one or " other of the organs, according to the disposition of the " person; the fever is announced by an unusual and continued " heat of the skin." (2nd edition, pp. 398 and 399.)

Several experiments, tried upon dogs, have proved to me that this salt acts with much less strength than corrosive sublimate when introduced into the stomach; the same thing however does not occur when it is injected into the veins: its action is then most murderous.

Experiment 1st. At eleven in the morning, there were injected into the jugular vein of a robust dog of large size, three quarters of a grain of the deuto-muriate of gold, dissolved in one drachm of distilled water: fifteen minutes afterwards, his respiration became difficult, and wheezing, with panting, suffocation, and vomiting of a white matter floating in froth. These symptoms went on increasing at such a rate, that at thirty-five minutes after one o'clock, the animal was suffering a great general uneasiness, uttered plaintive cries, and breathed with the greatest difficulty. At every expiration a very considerable noise was heard; he still preserved the power of walking; but remained lying down, and frequently changed his position. At half past four all these symptoms continued with increased force; he died an hour after.

Appearances on Dissection.—The lungs livid, except in a very few points, where they were of a rose colour; their texture was dense, hepatized, filled with blood, and not at all crepitating: when put in water, they remained just below the surface; the rose-coloured points only floated, and were

slightly crepitating. The mucous membrane of the stomach and intestines was sound.

Experiment 2nd. Half a grain of deuto-muriate of gold dissolved in two drachms thirty-six grains of distilled water, were injected into the jugular vein of a small dog: the animal felt no inconvenience; two days after he appeared to be in good health, and ate with an appetite. Being of opinion that the poison had not acted, because it was diluted with too great a quantity of the vehicle, we injected into the jugular vein on the other side a grain of the same salt dissolved in one drachm thirty-six grains of distilled water. Immediately after, the animal experienced vertigoes, and appeared suffocated; his inspirations were deep, his tongue pendant and livid; he uttered plaintive cries, and was senseless: he expired four minutes after the injection. He was instantly opened: the left ventricle of the heart contained some black blood, and contracted with difficulty: the contractions were much more strongly marked in the right auricle and ventricle. The lungs were shrivelled, in folds, crepitated but little, were discoloured, and hardly floated in water.

Experiment 3rd. Two grains of the deuto-muriate of gold, dissolved in one drachm thirty-six grains of distilled water, were injected into the jugular vein of a strong dog, though of small stature; immediately after, his breathing became difficult, the tongue and mucous membrane lining the mouth became livid; the animal experienced vertigoes, and uttered acute and excessively plaintive cries; he died three minutes after the injection. A minute before he expired, the crural artery was opened; the blood which issued was of a deep red colour, and that part of it which flowed a few seconds before death, was nearly black. The dissection was performed instantly after death: the heart was of a violet colour, and contained blackish blood in all its cavities: the auricles and ventricles still contracted at the end of three minutes. The volume of the lungs was considerably diminished, their colour was

inclining to orange, and their texture close, wrinkled, crepitating but little, and contained a small quantity of blood.

These experiments prove incontestably that muriate of gold, when injected into the veins, produces death by acting upon the lungs.

Experiment 4th. The œsophagus of a little dog was detached, and a hole pierced in it, through which three grains of deuto-muriate of gold in a solid form, enveloped in a small cone of paper, were introduced into the stomach; the animal experienced no pain. The two following days he was depressed and sorrowful, but walked about very well. He died during the night of the third day.

Appearances on Dissection.—The mucous membrane of the stomach, which was of a colour slightly inclining to rose, was abraded in three points without the viscus being pierced through; the muscular and serous membranes were untouched: the edges of these small wounds were not black; they exhibited the same rose colour as the rest of the membrane. The texture of the lungs was not hardened; it exhibited a few livid patches.

Experiment 5th. A small dog was made to swallow ten grains of the deuto-muriate of gold, dissolved in an ounce of distilled water; the animal vomited three times in the space of the first six minutes after the ingestion of the poison: the matter vomited was nearly all liquid, and in no great abundance. At the end of twenty minutes he threw up a great deal of frothy saliva. Two days afterwards, he ate with an appetite. He ran about and tried to make his escape. On the fourth day he began to refuse food; he grew lean, and was very much depressed. He died on the night of the seventh day.* The mucous membrane of the stomach, which was of a clear red colour, was ulcerated and in a state of sup-

* The temperature of the air was at 3° or 4° below zero; and the animal remained almost constantly abroad and at liberty.

puration in more than twenty points. The lungs appeared to be only slightly injured.

It follows from these experiments, that the deuto-muriate of gold, introduced into the stomach, acts as a corrosive, and that the animals sink under the inflammation produced by it in the coats of the digestive canal.

SYMPTOMS AND LESIONS OF TEXTURE PRODUCED BY THE DEUTO-MURIATE OF GOLD.

479. We are not acquainted with any case of poisoning by this salt; we are consequently obliged to refer our readers to the preceding article for the history of the symptoms and organic lesions.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY THE DEUTO-MURIATE OF GOLD.

480. The chemical properties explained in § 460 et seq. will suffice to recognise this salt when it is unmixed. If it should be necessary to seek for it in the matter vomited, or in that which may be found in the stomach after death; it must be filtered in order to obtain the fluid part, and tried by the tests proper for determining the existence of this saline solution, relying principally on the separating the metallic gold by means of evaporation and calcination: a few minutes of a red heat will suffice to effect the reduction of this salt. In those cases where the menstrua may furnish, with the solution of muriate of gold precipitates of a different colour to those we have mentioned, or that they produce no disturbance in the fluid, it will be indispensable to have recourse to calcination in order to obtain the metal, which is easily recognised by its yellow colour, and divers other characters explained § 454 et seq. This case will occur as often as the aliments and fluids

of the stomach shall have altered or decomposed the deuto-muriate of gold.

TREATMENT OF POISONING PRODUCED BY THE DEUTO-MURIATE OF GOLD.

481. To encourage vomiting by plying the patient with demulcent and mucilaginous drinks, to prevent, or to stop the progress of the inflammation of the abdomen, by the use of general and local bleedings, warm baths, glysters, and emollient fomentations; such are the means to which the man of science would have recourse in order to re-establish the different functions which have been affected by this poisonous substance. This treatment, similar to those we have mentioned at length in the article of different corrosives, presents no particular indication.

OF FULMINATING GOLD.

482. Fulminating gold is composed of ammonia, and deutoxyde of gold: it is solid, insipid, without smell, of a yellow colour, and is heavier than water.

483. When placed in a very small quantity upon the blade of a knife, and exposed to the flame of a candle, it detonates strongly in the space of two or three minutes, producing a report nearly as loud as that of a pistol. The same phenomenon takes place when it is suddenly rubbed, or when it is exposed to the focus of a burning lens.

Rationale. The hydrogen of the ammonia combines with the oxygen of the oxyde of gold, and forms water: then the other principle of the ammonia, the azote, passes suddenly into the state of gas, occupies a considerable space, gives a shock to the molecules of the air, and puts them into a state of vibration; at the same instant the water is reduced to a state of vapour, and produces the same effects. The

instantaneous formation of these gases, may be easily conceived, if we recollect, that the detonation never takes place till the temperature be raised.

484. Fulminating gold is insoluble in water.

485. Strong acids decompose it.

486. Plenck affirms, that the ingestion of this substance produces gripings, anxiety, spasms, convulsions, vomiting, diarrhæa, a copious salivation, faintings, and frequently death. *In duobus ægrotis a tribus granis auri fulminantis tormina, ingentem debilitatem, et profusissimam vidi salivationem.**

Hoffman speaks of having seen the fulminating gold given to persons labouring under quartan fever, and to hypochondriacs, in the dose of four or six grains, which produced gripings, spasms, anxieties, cold sweat of the extremities, a state of languor and fainting. The same medicine administered to a young lady of a delicate constitution, attacked with rheumatic fever, produced vomitings of a greenish matter, a great degree of anxiety, succeeded by fainting and death.

A child of six months old, was made to take six grains of fulminating gold in powder, with the intention of relieving the violent gripings with which it was affected. Shortly after, its extremities became cold, it was agitated with convulsive movements; and it died in a state of anxiety and extreme uneasiness.†

Rivinus mentions, having found holes in the intestines of a child poisoned with fulminating gold.

* Plenck Toxicologia, p. 241. Viennæ, 1785.

† Opera omnia Friderici Hoffmanni, tom. i. p. 227. Genevæ, 1761.

ARTICLE IX.

SPECIES IX.—PREPARATIONS OF BISMUTH.

VAR. 1st. *Nitrate of Bismuth.*
2nd. *Subnitrate of Bismuth (Blanc de fard).*

487. The preparations of bismuth have been greatly extolled of late, for correcting certain spasmodic affections: it appears incontestable that their employment has been sometimes attended with advantage. Nevertheless, M. Odier, who has had frequent opportunities of administering these kinds of preparations, has witnessed, that, under certain circumstances, they occasioned vomitings, diarrhæa, or constipation, an unpleasant heat in the breast, wandering shiverings, vertigoes, and drowsiness. M. Guersent has also seen the oxyde of bismuth produce colics, and anxiety, but without any evacuation. The experiments we have tried with these compositions upon living animals, leave no doubt of their poisonous qualities: therefore we do not hesitate, after the example of Plenck, Fodéré, &c. to rank them amongst the poisons of the mineral kingdom. We shall prefix to their chemical history some general notions concerning the metal which forms their base.

OF BISMUTH.

488. Bismuth is a solid metal, of a yellowish white colour, extremely brittle, exhibiting a texture of bright and large lamina. Its specific gravity is as 9,822.

489. It enters easily into fusion, and does not become volatile.

490. Oxygen is capable of combining with it, and forms the oxyde of bismuth, the colour of which is yellowish while dry, and white when it retains water *(hydrate)*. Charcoal, at a high temperature, easily revives this oxyde.

491. Bismuth dissolves extremely well in nitric acid; the solution, properly evaporated, furnishes prismatic crystals of rather a large bulk, known by the name of *nitrate of bismuth.* These crystals, when treated with boiling distilled water, become decomposed into two salts, one of which is soluble, the *nitrate with excess of acid*, the other insoluble, which is precipitated, and is a *subnitrate* of the same metal, that is to say of the oxyde of bismuth, retaining a little of the nitric acid. The properties of each of these compounds shall be explained in the following articles.

492. Sulphur combines with bismuth, and forms a sulphuret of a black colour.

CHEMICAL HISTORY OF THE NITRATE OF BISMUTH.

493. This nitrate, when crystallized, may, as we have just taken notice, be divided by distilled water into two very distinct parts: one soluble; the other insoluble (sub-nitrate).

PROPERTIES OF THE SOLUTION.

494. The soluble portion, *(acid nitrate)* which is colourless, reddens the tincture of tournesol, and is possessed of a styptic, caustic, disagreeable flavour.

495. When brought into contact with a great quantity of water, it presents nothing remarkable the instant the mixture is made; but after some time it is found decomposed, becomes milky, grows more and more turbid, and precipitates a small quantity of *sub-nitrate of bismuth* of a white colour: there remains in the fluid, nitrate of bismuth, still more acid than that we have described.*

* This character does not belong exclusively to the solutions of bismuth: the soluble salts of *tellure*, the muriate of antimony, &c. also precipitate by water.

496. Ammonia separates from it the white oxyde of bismuth, and combines with the nitric acid, with which it forms a nitrate.

497. Sulphurated hydrogen, hydro-sulphurated water, and the hydro-sulphurets decompose it immediately, and give birth to an insoluble sulphuret of bismuth, of a black colour.

498. Prussiate of potash gives with it a pale yellow precipitate, slightly inclining to green.

499. Chromate of potash gives rise to a precipitate of a beautiful orange-yellow colour.

500. The infusion of galls in alcohol decomposes it, and separates from it a flaky pale yellow-precipitate.

501. The same thing occurs with a very strong infusion of tea.

502. If one part of a saturated solution of acid nitrate of bismuth, be mixed with ten parts of Burgundy wine, a rose-coloured precipitate inclining to violet will be immediately obtained, and the supernatant fluid preserves the red colour of the wine: the hydro-sulphurets poured into this liquor when filtered, deepen the colour, and in the course of a few minutes, produce a black precipitate of the sulphate of bismuth. Ammonia deprives it of its colour without occasioning any sensible white precipitate. If, instead of employing one part of the acid nitrate of bismuth, four or five be added, the violet rose-coloured sediment is more abundant, and the red colour of the wine is not near so strong. Whatever may be the proportions in which these fluids are mixed; the metallic bismuth may always be obtained, by evaporating and calcining them with charcoal.

503. Gelatine produces no disturbance in this solution.

504. Albumine precipitates immediately the acid nitrate of bismuth; the precipitate is white, gelatinous, in tolerable abundance, and difficult to collect.

505. Human bile poured into a considerable quantity of acid nitrate of bismuth, decomposes it all at once, and

separates from it filamentous curds of a clear yellow colour, which does not change on the addition of a fresh quantity of bile.

506. Milk is completely curdled by this solution; the coagulum, which is white, subsides in the form of numerous curds, over which a transparent fluid is quickly perceived.

PROPERTIES OF THE SUB-NITRATE OF BISMUTH (*BLANC DE FARD*).

507. The sub-nitrate of bismuth is generally seen in the shape of white flakes, or of little lumps like mother of pearl. It is insoluble in water.

508. When treated by nitric acid at a temperature ever so little elevated, it dissolves completely, and in a very short time. The alkalies, when poured into this solution, decompose it, separating from it, the white oxyde: the hydro-sulphurets precipitate a black sulphuret of bismuth; lastly, distilled water, employed in sufficient quantity, gives birth to a white precipitate of *sub-nitrate of bismuth*, and an acid nitrate of this metal remains in the fluid, in every respect similar to that which we have just now described.

509. The *blanc de fard* when strongly calcined with charcoal becomes decomposed, loses its nitric acid, and the oxygen which partly constituted it; and the bismuth is set at liberty: this reduction presents nothing remarkable: it is similar to what we have already described several times.

ACTION OF THE NITRATE OF BISMUTH ON THE ANIMAL ECONOMY.

510. The preparations of bismuth which contain oxygen, are possessed of poisonous properties sufficiently energetic: if injected into the veins, or introduced into the stomach, they

are capable of producing death in a very short time. I have attempted to ascertain what is their mode of acting.

Experiment 1st. Twelve grains of crystallised nitrate of bismuth, were boiled for ten minutes, with three drachms of distilled water. The fluid was filtered, in order to separate from it the insoluble part which the water had precipitated. (Vide § 491), and it was injected, at noon, into the jugular vein of a small dog, in good health, and tolerably robust.* At four o'clock the animal had exhibited no particular phenomenon. The next day at ten in the morning, he made great efforts to vomit, and threw up, at four or five different attempts, a small quantity of liquid matter, (he had not taken any food for the last forty-eight hours): he uttered plaintive cries, and his limbs, especially the posterior ones, were agitated with a convulsive trembling sufficiently remarkable: the beating of the heart was very strong; it could be perceived at a great distance, and was very frequent: his breathing was a little accelerated and difficult: the animal made deep inspirations: he was dejected, very little sensible to external impressions, and remained lying upon his side. At half past one he was dying; the convulsive movements became still stronger, especially in the muscles of the posterior extremities; the respiration was somewhat more difficult; and he was seized with a general trembling. He died at three o'clock.

Appearances on Dissection.—The lungs were of a dark colour, crepitating in almost all their parts; they contained a great deal of air: there were in one of the right lobes, some small dense portions, similar in their structure to the spleen, and by no means crepitating. The stomach and intestines presented no remarkable alteration.

Experiment 2nd. The liquor proceeding from eight grains of crystallized nitrate of bismuth, which had been boiled for

* This liquor contained scarcely five or six grains of acid nitrate of bismuth.

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six minutes, in two drachms of distilled water, was injected into the jugular vein of a small dog. At the end of two days, the animal had felt no inconvenience. Then, the liquor obtained by boiling fifteen grains of the same crystallized nitrate, with the same quantity of water, was injected into the jugular vein of the other side. The animal was immediately attacked with vertigoes, he could not move a step without staggering; he fell down: if placed on his legs, he opened his paws in order to fall down again; his situation was extremely similar to that of persons intoxicated with wine. At the end of three minutes his breathing became difficult, he made deep inspirations; the tongue and mouth were extremely livid; he died eight minutes after the injection.

Appearances on Dissection.—The body was immediately inspected. The heart no longer contracted; the left ventricle was empty, or at least only contained a small quantity of black blood: the case was the same with the arteries: the lungs were shrivelled, wrinkled, and sufficiently crepitating; their colour was rather red.

There is no doubt, from these experiments, that the nitrate of bismuth injected into the veins, exerts its principal action upon the nervous system.

Experiment 3rd. At eleven o'clock a small dog was made to swallow sixty grains of sub-nitrate of bismuth; immediately after, his œsophagus was detached, and tied up. Six minutes had scarcely elapsed, when the animal experienced a nausea, and made efforts to vomit: his mouth was filled with white and stringy mucosities, and he uttered plaintive cries. At one o'clock, he appeared to suffer greatly: the efforts to vomit were repeated from time to time; his countenance was downcast; his posterior extremities trembling. The next day at noon he walked with ease, and shewed no other remarkable symptoms except dejection. He died in the night.

Appearances on Dissection.—The mucous membrane of the stomach was of a bright red colour throughout its whole

extent: that which lined the duodenum exhibited some small patches extremely red. The posterior part of the lungs was of a livid hue.

Experiment 4th. At eleven o'clock a small dog was made to swallow one drachm and forty grains of crystallized nitrate of bismuth, dissolved in an ounce of water: two minutes afterwards the animal vomited a white stringy matter, in which a part of the poisonous substance could easily be perceived. At the end of three quarters of an hour he had two other vomitings, not very copious. At one o'clock his breathing became impeded, sounding, and extremely profound, but not more frequent than usual. At seven in the evening the difficulty of breathing was still greater, and he appeared to suffer pain in the abdomen. He died in the course of the night.

Appearances on Dissection.—A great part of the mucous membrane of the stomach was nearly destroyed by suppuration; the slightest friction was sufficient to detach it in the form of pultaceous scraps: in the portion bordering upon the pylorus, it presented several ulcerations: the muscular coat appertaining to these portions was of a bright red colour, and separated easily from the serous coat: the same redness was likewise seen in several other parts of it. In the lungs were found several patches of a livid red, the texture of which was dense, similar to that of the liver, they were not crepitating, but contained a great quantity of serous mucosities and black blood: they did not float in water.

Experiment 5th. At four o'clock, a tolerably strong spaniel was made to swallow two drachms and a half of sub-nitrate of bismuth. The animal did not vomit, he suffered considerably during the night; and died the next day at noon. The mucous membrane of the stomach was extremely red, and ulcerated to the extent of about two inches: it was easily detached; that which lined the interior of the duodenum and jejunum was likewise extremely red: the lungs were distended with blood of a deep red colour, and were very little crepitating.

It follows from these three last experiments, that the nitrate and sub-nitrate of bismuth, when introduced into the stomach, corrode that viscus, and act at the same time upon the lungs. It does not appear at all doubtful, that the nervous system, being excited by sympathy, is the principal cause of death, especially where life is destroyed in a very short space of time.

SYMPTOMS AND LESIONS OF TEXTURE PRODUCED BY THE NITRATE OF BISMUTH.

511. Anguish, with very alarming anxieties,* nausea, vomitings, diarrhæa, or constipation, colics, an uncomfortable heat in the breast, wandering shiverings, vertigoes, and drowsiness, are the symptoms which the use of this salt has produced on human subjects. Our experiments on living animals have shewn us that it is capable of rendering the respiration extremely difficult, and that death was sometimes preceded by convulsions. The want of instances of this kind of poisoning, prevents us from giving a more extensive view of the subject. We can only repeat over again, on the subject of organic lesions observed in the dead bodies, what has been already described in § 510.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY THE NITRATE OF BISMUTH.

512. A. If the salt be free from mixture, it must be treated by boiling distilled water, which will dissolve only a part of it: the portion dissolved will act with the tests in the manner

* We read in the memoirs of the Academy of Sciences at Berlin, year 1753, a case, which informs us that this oxyde has produced remarkable anguish and anxieties.

we have described in § 492, *et seq.* The insoluble residue, when treated by nitric acid with heat, furnishes the acid nitrate of bismuth, the characters of which we had laid down under the articles *sub-nitrate of bismuth*, § 505, *et seq.* If the first experiments induce a belief that the compound under examination is either the nitrate or sub-nitrate of bismuth, the certainty of the fact may be ascertained by calcining it with charcoal in a crucible, and extracting the revived metal.

B. Camerarius makes mention of an adulteration of wine, by bismuth oxydated and dissolved in some acid.* Should the practitioner be called on to detect this fraud, he will attend to separating the metallic bismuth by evaporating the fluid, and calcining it in a crucible with charcoal. The use of the tests is here too uncertain for any importance to be attached to it, (§ 500.)

C. The bakers have sometimes made use of the oxyde and sub-nitrate of bismuth in order to render their bread heavier and whiter. It is chiefly in England that flour has been thus adulterated. (Vide *Gazette de Santé, by Maning.)* If the mixture be calcined in a crucible at a very high temperature, the vegeto-animal parts of the bread and flour will be soon decomposed, giving rise to several volatile productions, and to charcoal, which remains in the crucible, and revives the oxyde. If the metal obtained by this process possesses the properties described in § 488, *et seq.*; the practitioner may rest assured that it formed part of some preparation of bismuth.

D. When neither the fluids vomited, nor those found in the stomach after death, furnish upon chemical examination any of the signs necessary for pronouncing with certainty on the case of poisoning, by the nitrate or sub-nitrate of bismuth, we must then endeavour to discover whether the salts have not been decomposed by the food with which they are combined,

* Sylloges memorabilium Medicinæ et mirabilium Naturæ Arcanorum, cent. viii. pars. xxiij. p. 545, *Tubingæ*, anno 1683.

perhaps intimately; to this end, after having dried all the alimentary parts that are solid, membranous, &c.; they must be calcined in a crucible, in order to obtain from them the metal.

TREATMENT OF POISONING BY THE NITRATE AND SUB-NITRATE OF BISMUTH.

513. The different experiments we have made upon living animals, enable us to affirm, that of all the articles of medicine, milk, and sweet mucilaginous drinks, deserve the preference in the treatment now under consideration. Leeches, general bleedings, glysters, and fomentations, ought to be employed, whenever the symptoms give reason to apprehend the existence of inflammation of one or more organs.

ARTICLE X.

SPECIES X.—THE CONCENTRATED ACIDS.

VARIETIES. *The Sulphuric, Nitric, Muriatic, Phosphoric, &c. &c. Acids.*

OF SULPHURIC ACID.

514. It would hardly be thought, on first considering the subject, that the sulphuric acid should ever be employed by the unfortunate for the purpose of *suicide*. The horrible taste which it possesses, the energy with which it corrodes almost all bodies, whether organized or unorganized, would appear to cause it to be rejected by the numerous class of mechanics to whom these properties are perfectly well known. Unfortunately, experience proves that this powerful caustic has been had recourse to more than once, the activity of which has been thought to be modified by introducing it by the anus: death has generally quickly followed its ingestion.

How often too have we seen, by a fatal carelessness, this acid produce the most terrible symptoms!

These general considerations are sufficient to exhibit the importance of describing minutely whatever relates to this kind of poisoning.

CHEMICAL HISTORY OF THE SULPHURIC ACID (OIL OF VITRIOL).

Sulphuric acid is composed of

Sulphur, about	42 parts
Oxygen,	58
	100

or of

Sulphureous acid,	80 parts
Oxygen,	20
	100

515. Pure sulphuric acid is found in the form of a colourless fluid, void of smell, and of an oily consistence; it possesses an extremely strong acid taste, and its specific gravity is greater than that of water, the most concentrated weighs about 1,85. It reddens all the vegetable colours which are susceptible of it; a single drop is sufficient to give a red colour to a very great quantity of the infusion of tournesol; it blackens, and reduces to a pulp, all animal and vegetable substances.*

* The sulphuric acid of commerce, which has been exposed to the air, is often tinged with yellow, sometimes it is brown, and even black; this change of colour happens because this acid disorganizes and carbonates the vegetable and animal matters which are found suspended in the atmosphere.

516. When sulphuric acid and charcoal finely powdered, are made to boil together in a small phial, a pungent smell will soon be observed to proceed from them, similar to that of burning sulphur, which distinguishes the sulphureous acid gas: carbonic acid gas is at the same time formed.

Rationale. The charcoal decomposes the sulphuric acid, lays hold of a portion of its oxygen, passes into the state of carbonic acid gas, and converts the sulphuric acid into sulphureous acid gas.

517. Mercury, when made to boil with this acid, carries off a portion of its oxygen, disengages sulphureous acid gas, becomes oxydated, and unites with a portion of the acid not decomposed, with which it forms a white mass, known by the names of *proto-sulphate* or *deuto-sulphate of mercury*, according to the quantity of acid employed and the time which the ebullition has been kept up.

518. When equal parts of concentrated sulphuric acid and water are mixed together, for instance 250 *grammes*, the temperature is suddenly elevated to 84°. of the *centrigrade* thermometer. If twice the quantity of acid be employed, and half the quantity less of water, the caloric which is disengaged, causes the thermometer to rise to 105°. These phenomena are the consequence of the very strong attraction which takes place between these two fluids, of their intimate penetration, and consequently of the expulsion of a part of the caloric which extended them.

519. Straw, wood, and all vegetable substances, when immersed in sulphuric acid without heat, are disorganized, softened, blackened, and there is separated from them a certain quantity of charcoal; the acid is found to contain after the experiment considerably more water than before.

Rationale. The sulphuric acid, from its great tendency to unite with water, solicits and effects the separation of a portion of the oxygen and hydrogen of the vegetable substances, and the carbon is left at liberty.

520. When poured into the water of barytes, this acid instantly produces a white precipitate in very great abundance, which is insoluble in nitric acid, known under the name of *sulphate of barytes;* the same phenomenon takes place if, instead of the barytes, a solution of the nitrate or muriate of that base be used. When washed, dried, and calcined with charcoal, this precipitate is decomposed in the course of an hour, and furnishes sulphate of barytes, easily known by the smell of rotten eggs which it gives out when put into water sharpened with a small quantity of muriatic acid, and by the precipitation of a part of the sulphur which subsides, rendering the liquor milky and of a yellowish white colour. A formation of muriate of barytes takes place at the same time.

521. When mixed with the acetate or nitrate of lead, this acid immediately produces a white precipitate extremely abundant, consisting of sulphuric acid and protoxyde of lead.

522. It produces no change in sugared water.

523. It brightens the colour of wine.

524. A strong infusion of tea, brought in contact with the sulphuric acid, does not lose its transparency, or change its colour.

525. When united to vinegar in small quantity, it does not render it turbid, but greatly increases its acidity. The presence of sulphuric acid in this mixture can be easily detected, by adding to it some carbonate of lime (chalk) in powder, till there is no longer any effervescence. The two acids, the acetic and sulphuric, combine with the lime and produce a soluble acetate of that base, and an insoluble sulphate: so that by decanting the liquor, and slightly washing the sediment, all the sulphate of lime formed in the experiment will be obtained upon the filter. In order to demonstrate the existence of sulphuric acid in this precipitate, we should begin, 1st. by dissolving a portion of it in boiling distilled water; the solution being filtered, and brought in contact with water of

barytes, or, what is still better, muriate of barytes, will furnish a precipitate of sulphate of barytes, insoluble in water, and in nitric acid. 2ndly, The other portion should be mixed and calcined for two hours, in a high temperature, with one fourth of its weight of charcoal finely powdered: at the end of this time, the sulphuric acid will be found to be decomposed by this combustible body, and the product of the calcination will contain sulphuret of lime, which may be recognised by the means we have pointed out in § 120, et seq.*

Mercury would be of no use for detecting the presence of a small quantity of sulphuric acid in adulterated vinegar. I boiled, for a long time, a mixture of mercury, vinegar, and a little sulphuric acid: I adapted a curved tube to the mouth of the phial, and could neither obtain sulphureous acid gas, nor acid sulphate of mercury (vide § 517).

526. The solution of gelatine, far from being rendered turbid by the sulphuric acid, becomes more limpid.

527. Albumine is copiously precipitated of a white colour by this acid.

528. Milk is instantly curdled.

529. When one or two drops of sulphuric acid are let fall into a tolerable quantity of human bile, a beautiful precipitate of a clear yellow colour is instantly obtained, which is nothing else than the animal matter of the bile, designated by the name of *yellow matter*. A greater quantity of sulphuric acid makes the mixture change to an orange yellow, and, at the

* It has been said, that the presence of sulphuric acid in vinegar might be determined, by adding to it a few drops of a solution of muriate of barytes; and that the white precipitate, which is insoluble in water, and in nitric acid, would be a proof that free sulphuric acid exists in it. It is easy to prove that this process is altogether defective. It is well known that all vinegars contain sulphate of lime and sulphate of potash in solution; now, the barytes lays hold of the sulphuric acid in whatever situation it may find it. In which case this precipitate will always be obtained whenever a solution of barytes is poured into vinegar.

end of four or five minutes, a few slight flakes of a deep green colour are thrown down. We shall avail ourselves of these facts when we describe the lesions of texture produced by this powerful corrosive.

530. Sulphuric acid, being mixed with fluid blood, coagulates and decomposes it: if the acid be concentrated, it turns it of a deep brown, and carbonates it.

ACTION OF SULPHURIC ACID ON THE ANIMAL ECONOMY.

531. A small quantity of this powerful caustic is sufficient to produce the most serious accidents, succeeded almost always by death, and that, whether injected into the veins, or taken into the stomach, or even applied to the external surface of the body.—In what manner does this acid produce death?

Experiment 1st. Thirty-six grains of sulphuric acid, mixed one hour before, with thirty grains of water, were injected into the jugular vein of a robust dog of large size. At the same instant the dog fell down, his extremities became stiff, and he died. The body was immediately opened. The heart was swelled of a vast bulk, and its sides presented a much greater resistance than in their natural state; the two ventricles were filled with a multitude of small clots as black as charcoal: the left auricle and the aorta, contained gelatinous *coagula* of a blackish red colour: the abdominal *vena cava*, which was extremely dilated, and firm to the touch, contained clots similar to those by which the ventricles were distended; the lungs were of an ash colour, of a dense texture, no way crepitating, and completely destitute of air; on cutting into them, their whole surface appeared strewed with black points, which were only coagulated blood; several ramifications of vessels running through them were injected, hard, of a black colour and cy-

lindrical form, resembling in their appearance and size, small cylinders of lunar caustic: on cutting into them, they were also found filled with coagulated blood.

Experiment 2nd. A strong dog was made to swallow about two drachms and a half of sulphuric acid, which had been mixed an hour before with one drachm thirty-six grains of water: the animal immediately began to feel a great degree of uneasiness and agitation; his breathing became extremely difficult; he uttered moans excessively plaintive, threw himself down, and often shifted his position: he died thirty minutes after the ingestion of the poison. He was opened at the same moment. The mucous membrane of the stomach was black, and easily detached; the muscular coat, which was red in patches, exhibited no ulceration; the duodenum presented a yellow covering, thick and flaky, easy to detach.* The blood contained in the ventricles of the heart, was coagulated, sizy, and of a blackish red colour. The lungs, which were very little crepitating almost throughout, presented black patches, which were hardened, of a close texture, and distended with black coagulated blood, exactly resembling that described in the preceding experiment.

The state of these last organs, the symptoms which the animal experienced, and the rapidity with which it sunk under them, made me suspect, that in the efforts of deglutition, a part of the acid had fallen into the trachea, and consequently that this experiment could not throw any light upon the mode of action of this corrosive when introduced into the stomach. The following fact will prove incontestably how well my suspicion was founded.

Experiment 3d. At five minutes after twelve at noon, the œsophagus of a small, but very strong dog, was detached and perforated: two drachms of concentrated sulphuric acid, mixed

* There is no doubt that this coat was formed by the yellow matter of the bile set at liberty by a small quantity of the sulphuric acid, which had passed the pylorus (§ 529).

an hour before with one drachm of water, were introduced into the stomach, and the œsophagus was tied. Ten minutes afterwards the animal experienced horrible sufferings; he made great efforts to vomit. At one o'clock he continued uttering plaintive cries; he made fresh and fruitless efforts to vomit; his breathing did not appear at all incommoded. Half an hour afterwards, he had great inclination to vomit, and was agitated to that degree, that he broke the thread with which the œsophagus had been tied, and which was partly burnt by the sulphuric acid. He instantly threw up a great quantity of a matter as black as ink, and of the consistence of a thick liquid, similar in appearance to sulphuric acid which has remained a long time upon straw, or upon matches. His sufferings continued very severe, and obliged the animal to remain lying upon his belly. He died at half past three.

The body was opened a quarter of an hour afterwards. The heart contained blood which was not coagulated; that in the left ventricle was red, slightly inclining to black. The lungs, which were of a natural colour, contained a tolerable quantity of air, they were crepitating, and a sound was heard from them when cut. The blood-vessels which traversed them were empty; their texture however appeared somewhat more compact than in their natural state. The mucous membrane of the stomach was destroyed; it had been partly expelled by the vomiting. The muscular coat, which was of a cherry red, was covered over in some points with a sort of blackish pulp, and exhibited several small ulcerations. The pylorus was lined with a coat of a greenish yellow colour. The interior of the duodenum was covered with a flaky yellow coat, formed of the yellow matter of the bile.

Experiment 4th. Animals on which wounds had been made, and cauterized with a great quantity of the sulphuric acid, died at the end of a time which is variable, without the interior organs exhibiting any alteration.

We must conclude from these facts. 1st. That the sulphu-

rated acid injected into the veins, destroys life, because it coagulates the blood, by exercising upon it a true chemical action by so much the more powerful as the quantity injected is more considerable. 2ndly. That when introduced into the stomach, it produces a speedy death, by inducing inflammation and disorganization of that viscus, which quickly re-acts upon the brain, by means of numerous nervous ramifications. 3dly. That when applied externally, the animal sinks under the first effects of the burning it occasions, or else the copious suppuration which succeeds to it.

SYMPTOMS OF POISONING BY SULPHURIC ACID.

OBSERVATION 1st.

Joseph Parangue, a soldier, about the end of January, 1798, between seven and eight o'clock in the morning, swallowed, precipitately, and by mistake, instead of brandy, a full glass of sulphuric acid (oil of vitriol): he drank it off at once, with his head held back, and pouring it from a distance above his mouth, by which means he did not discover his mistake until he recovered his breath. He was instantly conveyed to the hospital: being informed of the accident, I arrived there at the same time as the patient. Excessive vomitings had already taken place, as well as convulsive agitations of the muscles of the face and lips, being the first effects of the violent pains he complained of throughout the whole extent of the parts with which the poison had been in contact. He said that he felt cramps excessively painful in the breast, and an acrid, burning heat in the throat, along the œsophagus, and in the stomach. An icy coldness extended over the whole body: I found the pulse small, concentrated, irregular; I will say more, almost convulsive, tremulous, at one time very quick, at another slow and suspended; his breathing was difficult, and the whole epigastric region painful; but what I more particularly

paid attention to, was the extreme melancholy state of the patient. It is difficult to give an account of his state of terror; he considered himself altogether without a chance of recovery; his eyes were dim, and he performed only some feeble motions. I instantly told him of a certain antidote, of a counterpoison which has never failed in its effect; I thus raised his courage, and gave him a draught composed of half a glass of simple water, with which a drachm and a half of carbonate of magnesia had been mixed; his eyes became a little animated, and his weakness appeared rather less; the idea of a speedy and real cure suspended for a moment the formidable train of moral symptoms, which were of themselves capable of conducting the patient to the tomb. Half a quarter of an hour after, he vomited again, but less, and with less exertion and fatigue. I gave him half a drachm more of the carbonate of magnesia, and he complained then only of nausea; his internal pains were less acute. I continued the remedy in the dose of a scruple every half hour, and caused him to take in the intervals, a few glasses of a solution of gum arabic sugared. Before noon the symptoms had diminished sensibly of their violence; his breathing was more free, the anxieties of the præcordia had nearly ceased, the internal sensation of tearing very much weakened; the pulse rose, unfolded itself, and became regular: a genial heat was diffused over the whole body.

I had succeeded in checking the destructive and deleterious effects of the caustic fluid; but there remained still to remedy the disorders which its immediate contact in the interior had occasioned.

A copious bleeding from the arm at one o'clock; emollient fomentations to the stomach and the whole of the abdomen during the rest of the day, and an opiated and camphorated liniment during the night; a drink of linseed tea with gum arabic and syrup of marshmallows, taken warm and copiously, &c. &c. prevented those consecutive symptoms which an event of this nature would give reason to dread; a glyster with

honey, given in the evening, produced bilious evacuations tolerably abundant, and six drachms of the syrup of diacodium added to a glass of ptisan, procured rest during the night; his sleep was however light, and was often interrupted by pains which the patient felt at his stomach, and still more, and in a stronger degree, in the throat. The next day at my morning visit, I examined this last part with attention; almost the whole of the mouth was inflamed; the *velum palati*, its anterior and even its posterior columns, the *amygdalæ*, and the uvula, were covered with white, and seemingly superficial eschars on the sides, and with black scabby and deeper ones on the soft appendage of the palate. The whole of the fauces appeared to be strongly burnt. Fortunately deglutition was not prevented; it was not even painful or laborious, compared to the accompanying symptoms. A lenitive and mucilaginous drink was administered, with a white linctus taken frequently by a spoonful at a time, two glysters in the twenty-four hours, emollient fomentations upon the abdomen, during the day, and the lenitive was continued during the night: every kind of food was forbidden. On the third day the patient complained greatly of his throat, and a fresh panic seized him; he thought himself threatened with suffocation, and the danger appeared to him to be imminent. The tumefaction of the burnt parts had increased, and the root of the tongue was elevated and corroded, the epiglottis also partook of the disease: all these parts were burning with a violent and consuming heat: the uvula elongated and covered with sloughs, the *amygdalæ*, already in a gangrenous condition on their anterior surface, and grayish, or aphthous spots scattered here and there over the fauces, presented the appearance of a gangrenous sore throat of the worst kind. The voice too had undergone a considerable alteration.

On the fourth day, a soft and fleshy portion, which became detached from the uvula, by elongating it, tormented the patient in a most grievous manner in the throat, by producing

an irritation, and exciting a cough which was both fatiguing and annoying on account of its frequency. His breathing became more difficult, and sometimes interrupted, sometimes attended with a hissing noise, especially during inspiration; and his voice assumed the peculiar character of that which occurs in the species of quinsy known by the name of the *Croup*.

The mucilaginous drinks, the white linctus, or one made of spermaceti, oil of sweet almonds, yolk of egg, and syrup of marshmallows, served at the same time for drink, gargle, and nourishment. I touched the diseased parts several times in the day with lint on a pair of forceps dipped in a mixture of honey of roses, and tincture of myrrh: I afterwards added some collyrium of Lanfranc, sharpening the whole with an equal quantity of decoction of agrimony. External anodyne applications were not neglected, as well as cataplasms of bread boiled in a decoction of camomile and melilot. As fast as I could seize hold of the loose sloughs with the forceps, I cut them away, in order to free the throat quickly from them.

On the fifth day I beat up a yolk of an egg, with a glass of ptisan, which was taken at two different times, in order to lubricate and as it were *varnish* the parts of the fauces which were excoriated, and to prepare them for taking a little nourishment: the same medicines continued.

On the sixth; a similar treatment, and the yolk of egg, morning and evening. The external swelling of the throat almost dissipated altogether, the tumefaction within also greatly diminished, the sloughs in a great measure fallen off, and many of the ulcers quite clean.

On the seventh; still better: from the close of this day all danger may be considered to have disappeared: the quantity of medicine and attentions have been diminished in proportion as food has been had recourse to.

I forgot to mention, that a drop of the sulphuric acid had fallen upon the upper lip at the moment of the accident, and

produced a slough which made a long resistance. For a still longer period this soldier retained a redness and painful sensibility in the throat, as well as a painful sensation at the stomach, especially when he ate hastily, or food that was indigestible.*

OBSERVATION 2nd.

A student, who wished to remedy a caries of a tooth for a young woman, poured into her mouth such a quantity of *oil of vitriol*, that her throat and stomach were strongly attacked by it, and eroded in several places. A violent heat and smell succeeded, inseparable attendants upon inflammation of the internal membranes, which, notwithstanding the bleedings, and every kind of cooling and laxative medicines which were exhibited, ended by an eruption of pimples, with foul ash-coloured crusts, over the whole surface of the body.†

OBSERVATION 3rd.

A dyer of the commune of Arfeuille, went to bed at midnight extremely drunk. He shortly after awoke, and found himself tormented with thirst. He got up, sought amongst a number of bottles to find something to quench his thirst, and laid hold of one containing sulphuric acid. He swallowed a few drops of this liquor, but soon finding out his mistake, he applied instantly for help. M. Pingusson hastened to his relief. He mixed up, in a certain quantity of water, prepared crab's eyes, and made him swallow a few draughts of it. This dose was sufficient to allay the consuming heat which was felt in all the parts which the acid had corroded: but it

* Recueil Périodique de la Société de Médecine de Paris redigé par Sédillot, tom. vi. p. 3. an. 7, par M. Desgranges.

† Observation taken from the practice of *Tulpius*, and reported by M. Desgranges, Recueil Périod. de la Société de Méd. redigé par Sedillot, tom. vi. p. 22.

was not possible for him to take a second, on account of the rapid progress which the swelling of the interior of the pharynx and œsophagus had made; and he was obliged to be supported for three weeks by glysters of strong broth given three or four times a day. When deglutition was restored, he was made to take milk, mucilaginous drinks, &c.; and in a short time was perfectly recovered.*

OBSERVATION 4th.

Louisa Delay, aged twenty-two years, took, on the 13th Germinal, year 8, at eleven in the morning, an ounce of *blue composition* (a mixture of sulphuric acid and indigo) which she had bought of a grocer-druggist, on purpose to destroy herself. She was made to drink oil and milk. The following was her condition when brought to the Hotel-Dieu, four hours after she had swallowed the poison.

Countenance not much changed; exhibiting however a tinge slightly blue, which was deeper round the edge of her lips; dull pain in the throat, and in the region of the stomach: repeated and very copious vomitings of a deep blue-coloured and glairy fluid; which caused in the mouth a sensation of intolerable bitterness and stypticity: continual feeling of cold on the skin, which was become very dry; horripilations from time to time; constipation, watchfulness, inquietude which could not be concealed, &c. &c.

She was made to drink copiously of whey, of a decoction of linseed, solution of gum arabic, milk diluted with barley-water: purgative glysters were administered, and an oily julep with manna, to provoke the natural evacuations, which were suspended, or confined to a very inconsiderable stool, and the passage of a few drops of urine. The matter vomited contained a great quantity of flakes of lymphatic substances, of an insipid smell, some floating on the surface of water, others

* Journal de Médecine, Avril, 1810, par M. Pingusson.

sinking to the bottom: the pulse, which appeared to be little altered at first, became small, tight, and extremely thread-like; the cold of the inferior extremities increased greatly.

At the end of two days, all the symptoms had acquired a great degree of intensity: the face appeared particularly deranged: the cold on the surface increased still more; the pulse became insensible in the wrists and in the carotids; the breath was extremely fetid; a few drops of urine, excessively high coloured, escaped from time to time; the disquietude and agitation were extreme.

This unfortunate young woman could not bear any kind of covering; she was continually making painful efforts to put away every thing which touched her, or came close to her, and threw her arms and her head out of bed; the region of the stomach was exquisitely sensible to the slightest contact.

The fourth day of the poisoning, the anxiety and anguish were horrible; the whole external surface of the body shewed signs of suffering. The patient, incapable of resting a single instant in the same position, rose up and got out of bed; she seemed to express the most ardent wish to be removed into a cold place.

On the fifth day, her eyes were haggard; she seemed to find some relief in being disencumbered of her shift, which she still continued to push off till on the eve of expiring: that she was obliged to be tied down.

The rest of the treatment administered with so little benefit to her, consisted in emollient and mucilaginous drinks, simple and purgative glysters, laxative and antispasmodic draughts. Leeches were also applied once or twice to the pudenda.

The countenance was changed to such a degree, that it was impossible to recognise her person. The cords with which she was fastened could not prevent her, so powerful were her endeavours, from uncovering the greatest part of her body, which appeared to give her great relief. She preserved her

reason to the last, continuing to converse with those persons who surrounded her. She expired on the fifth day from the accident.

On opening the abdomen there arose a great quantity of very fetid gas; the abdominal viscera were for the most part œdematous; all the parts in the neighbourhood of the duodenum had undergone a peculiar alteration; the coats of this viscus were in several places nearly dissolved. The stomach, which was greatly distended, and of a dark colour, exhibited several spots, which shewed its deep disorganization. The mucous membrane of the œsophagus was burnt, blackish, partly detached, and was easily removed.

The stomach contained a foul fluid of a dark colour, and very fetid, similar to what she had vomited the day of her death. This organ appeared very much thickened in some points, and wasted in others. The internal coat was entirely dissolved and reduced to a state of mucus throughout the greatest part of its extent. The pylorus exhibited the most advanced state of disorganization; the texture of its coats, which were black and puffed up in this place, almost closed up the orifice; the membranes of the duodenum and of the jejunum, which were partly destroyed, and burnt, were attacked with sphacelus; these intestines were lined withinside with a brown matter, similar to that found in the stomach. The rest of the intestinal canal partook more or less in the mischief; a great quantity of hardened fæces was found in them. The interior of the thorax presented nothing very remarkable.*

532. The following are the symptoms of poisoning by sulphuric acid: an austere, acid, styptic, and very disagreeable taste; an acrid and burning heat in the throat, along the œsophagus and in the stomach; an acute pain in the throat, an intolerable fœtor of the breath, nausea, and excessive vomitings.

* Tartra; Essai sur l'Empoisonnement par l'Acide Nitrique, p. 251. 1802.

The fluid vomited, is at one time black as ink, at another time reddened by arterial or venous blood, and produces in the mouth a sensation of bitterness and stypticity quite intolerable; it effervesces on falling on the pavement; constipation, or sometimes bloody stools; gripes and excruciating pains over the whole of the abdomen, on which it is sometimes impossible to lay the hand, or even the lightest object; pains of the breast; difficulty of breathing; anxiety, anguish; the pulse frequent, small, concentrated, irregular, and extremely thread-like; a constant sense of coldness of the skin, horripilations; extreme dejection, great restlessness and agitation; the countenance not much altered at first, but afterward undergoing a great change; convulsive startings of the muscles of the face and lips, free exercise of the intellectual faculties, and sometimes an eruption of pimples upon the skin. Frequently the uvula, amygdalæ, *velum palati*, &c. covered with sloughs either white or black, which, on becoming detached, torment and irritate the patient, and produce a fatiguing cough; the voice in that case becomes altered, and similar to what distinguishes the croup.

LESIONS OF TEXTURE PRODUCED BY SULPHURIC ACID

533. If the sulphuric acid has been swallowed without mixture with any other substance, there are seen after death alterations more or less profound in the texture of the parts with which it has come in contact: at one time, there is only a redness of the pharynx and stomach; at another, these parts are wholly or in part ulcerated, or gangrenous, or reduced to a black jelly. The phenomena observed in the dead body will be somewhat different when the acid taken contains indigo in solution. This preparation, known under the name of *blue composition*, is employed in dying, and is often used by persons to destroy themselves. We consider it necessary to

call the attention of physicians to the condition of the bodies of persons who have died in consequence of the use of this mixture.

At thirty-five minutes after twelve o'clock, a small dog was made to swallow a drachm and half of *blue composition* (a liquor consisting of concentrated sulphuric acid and indigo). Immediately after, the animal threw himself down, and rolled about the ground with great violence; he seemed to have had the pharynx burnt by the caustic, as he sought to relieve the effects of it by rubbing his neck against a plank on which he was placed; he frequently changed his position; at one time he was lying upon the back, at another time upon the belly, and uttered continually plaintive cries. At the end of ten minutes he vomited some stringy matter strongly coloured with blue; this vomiting was repeated four times in the course of the first thirty minutes succeeding the ingestion of the poison. At half past three he had vomited a great quantity of this stringy matter, mixed with black blood partly coagulated; he continued to complain, but had still power to walk; he died during the night.

Appearances on Dissection.—The mucous membrane of the mouth, tongue, and œsophagus, were of a deep green colour; the pharynx was of a cherry red; the same appearance was observed on the inferior surface of the epiglottis and larynx. The interior surface of the stomach was black throughout its whole extent, excepting a few points near the cardia, where it exhibited a greenish, or yellowish tinge.* Over the muscular coat, were scattered, here and there, spots of a very bright red.

* The yellow tinge depends on the existence of a small portion of the *yellow matter* of the bile, set at liberty by the sulphuric acid, and the green tinge appears to be the result of the union of this yellow matter with the blue colouring part of the indigo.

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APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY SULPHURIC ACID.

A. If this acid is without mixture, it is easily known by its specific gravity, by the action, which it exercises on cold water, on the salts of barytes, on straw, matches, &c.: lastly, by the decomposition it undergoes when boiled with mercury. *(Vide § 515 et seq.)*

B. When sulphuric acid is combined with wine or vinegar, the practitioner will easily determine its presence by operating as directed § 525.

C. If it should be necessary to decide upon the existence of this acid in the *blue composition*, it will be easily effected by paying attention to the following directions. 1st. This liquor is of an excessively deep blue colour; it is thicker than sulphuric acid, and its consistence is extremely oily. 2ndly. It reddens the tincture of tournesol, and raises the temperature of water, when a small quantity of it is combined with this fluid. 3dly. If evaporated to dryness it gives out very heavy white vapours, of a very poignant smell, which depends upon the volatilization of part of the sulphuric acid; there remains in the capsule some shining charcoal. 4thly. When heated with mercury, it is decomposed, and gives out sulphureous acid gas, easy to be distinguished by its poignant smell, similar to that of burning brimstone. 5thly. Lastly; if sulphuric acid be saturated with a solution of caustic potash, it changes to a green colour; if it be evaporated in this state, dried, and calcined during a quarter of an hour, it leaves charcoal proceeding from the decomposed indigo, and sulphate of potash. This salt may be dissolved in water, and converted into an insoluble sulphate of barytes, by the addition of a sufficient quantity of some soluble salt of barytes (§ 520). It will be much better to precipitate the sulphuric acid thus when the

indigo has been decomposed by fire, than to put a salt of barytes into the *blue composition* itself, diluted with water.

D. If the acid should be found amongst the fluids vomited, or those contained in the stomach, a portion of this matter should be boiled with metallic mercury, in order to obtain sulphureous acid gas: another portion should be saturated with carbonate of lime, and the sulphate of lime formed should be treated in the manner laid down § 525. The water and salts of barytes would be of no utility, without taking the precautions we have pointed out; because a certain quantity of sulphates may be found in the stomach.

TREATMENT OF POISONING BY SULPHURIC ACID.

534. Does there exist any antidote to sulphuric acid?

In examining with attention the different chemical re-agents capable of arresting the fatal action of this poison, I have been of opinion that calcined magnesia, proposed by Peltier, and employed in the human subject, by M. Desgranges, is the medicinal substance which might be administered with the greatest success.

Experiment 1st. At ten o'clock in the morning, the œsophagus of a small dog was detached and perforated, and by means of a tube of elastic gum and a funnel, two drachms of sulphuric acid, mixed an hour before with a drachm of water, were introduced into the stomach; six minutes after, three ounces of water mixed with two drachms of calcined magnesia were likewise introduced; the œsophagus was then tied below the opening to prevent vomiting. Immediately after the animal appeared to feel some pain; at the end of an hour he made violent efforts to vomit; he broke the ligature, and threw up a great quantity of white matter. At four in the afternoon, he uttered plaintive cries, and died two hours after.

Appearances on Dissection.—The mucous membrane of

the stomach and duodenum were for the most part of a bright red colour; the veins of the internal surface of this viscus were filled with black blood, having the appearance of having been injected; the smallest ramifications might be distinguished; near the cardia were found some black patches formed by extravasated blood.

Experiment 2nd. At eleven o'clock, the œsophagus of a middle-sized dog was detached and perforated, and two drachms of sulphuric acid mixed an hour before with three drachms of water, were conveyed into the stomach, in the manner before described: eight minutes afterwards, six ounces of water with four drachms and a half of magnesia were introduced, and the œsophagus tied. At one o'clock the animal made violent efforts to vomit, he was dejected, but made no complaints. He died the next morning at six o'clock, being nineteen hours after the introduction of the poison. The mucous membrane of the stomach, which was not very red, was eroded in several points; the portions of the muscular coat corresponding to these points, were of a cherry-red colour.

In order to appreciate better the effects of the magnesia, the following experiment was instituted.

A dog about the same size as that of the first experiment, was selected, and two drachms of sulphuric acid, mixed an hour before with two drachms of water, were conveyed into the stomach; and at the end of six minutes, four ounces of water were likewise introduced: the œsophagus was immediately tied. The animal instantly made violent efforts to vomit; he experienced a general uneasiness, lay down upon his belly, and uttered very piercing cries; at the end of a quarter of an hour he made frightful howlings; he appeared to have the belly burned, and made great exertion to vomit: his breathing was considerably accelerated. He died two hours and a half after the poison had been received, amidst the most horrible torments.

Appearances on Dissection.—The mucous membrane of

the stomach was nearly destroyed, and converted into a thick pulp; those portions which were not completely disorganized, presented a black colour, and were very easily detached from the muscular coat, which last was of a cherry-red. On the internal surface of this viscus, especially about the pylorus, the vessels appeared strongly injected of a black colour.

From these experiments we may draw the following conclusions. 1st. That magnesia administered a very short time after the injection of the sulphuric acid, does not prevent the poisoning of animals whose œsophagus has been tied, even when employed in a dose double what is necessary for the neutralization of the acid. 2nd. The dogs to whom it was given, nevertheless suffered much less than those who had taken nothing but water; they lived longer, and the texture of their organs was less corroded. It is probable that if, instead of tying their œsophagus, they were left at full liberty to vomit, and the medicine had been repeated to them several different times, all the portions of the sulphuric acid concealed in the foldings of the mucous membrane, would have been neutralized, and the force of the poison greatly diminished; and perhaps by these means the health of the animal might be restored.* 3dly. That practitioners ought not to flatter themselves with the hope of arresting the mischief produced by sulphuric acid, by the use of this remedy, only when it can be given in a very short time after the accident has taken place, and repeated several different times.

535. From these considerations it follows, that the physician ought, without losing an instant of time, to ply the patient with copious drinks containing magnesia in suspension.†

* When an animal has swallowed a certain quantity of a corrosive acid, it is scarcely possible to introduce any thing else into its stomach, on account of the violent resistance it makes to it.

† This earth in its pure state, ought to be preferred to the carbonate, which labours under the inconveniency of disengaging a quantity of carbonic acid gas in the stomach, by which this viscus becomes prodigiously distended.

If this cannot be procured, soap and water may be administered with advantage. Mucilaginous drinks, milk, and even warm or cold water, ought to be thrown in in great abundance, until the medicine we have spoken of can be procured. It must never be lost sight of, that the success in this case depends upon the activity of the practitioner; a few moments of delay will completely change the fate of the patient, as the sulphuric acid destroys the texture of the organs with a dreadful celerity. After having neutralized the caustic, we must endeavour to remedy the mischief it has produced. If the symptoms, notwithstanding the degree of abdominal inflammation, do not already announce the corrosion of the digestive organs, general and local bleedings should be employed, and emollient glysters, continuing the use of sweet and mucilaginous drinks. The mischief produced in the mouth by this acid, ought to be considered as a local disease, and to be treated by the method which succeeded so well in the case which forms the subject of the first observation (page 317).

OF NITRIC ACID *(AQUA FORTIS).*

536. A slight glance over the numerous cases of poisoning collected up to the present time, is sufficient, to convince any one, that of all the mineral poisons, the nitric acid is that which has been the most frequently employed for the purpose of suicide, and the effects of which have been the most frequently fatal; this two-fold consideration induces us to enter minutely into the details of its history.

PHYSICAL AND CHEMICAL PROPERTIES OF THE NITRIC ACID.

537. Pure nitric acid is in the form of a colourless fluid; it is possessed of an odour, and acid taste so acrid and caustic,

that it burns and destroys organized matter; its specific gravity is as 1,554. A single drop of this acid reddens a great quantity of infusion of tournesol. It instantly colours the skin or other parts of animals, giving to them a tinge more or less yellow.*

538. When heated in a small phial with charcoal, sulphur, or phosphorus, it becomes decomposed in the course of a few minutes' ebullition; a portion of its oxygen fixes upon one or other of these combustible bodies, acidifies it, and there is disengaged nitrous gas (deut-oxyde of azote) which passes into the state of nitrous acid gas of an *orange yellow* colour, by absorbing the oxygen contained in the atmosphere.

539. Nitric acid poured upon copper filings, produces a brisk effervescence, gives out orange-yellow vapours (nitrous acid gas), and becomes converted into *nitrate of copper* of a green colour, which soon becomes blue. *Rationale* (vide § 290).

540. Potash, soda, barytes, strontian, &c. when combined with nitric acid, forms salts, with the properties of which the juridical physician ought to be well acquainted. 1st. These nitrates, when evaporated, dried, and placed upon red hot charcoal, enliven its combustion, and produce an inflammation so rapid, that a considerable disengagement takes place of light and caloric, and an expansion which occasions more or less report and projectile movement. When mixed with sulphur, and thrown into a red hot crucible, they inflame on a sudden, and give rise to a very bright combustion. These different effects depend upon the sudden decomposition of the salt, and the fixation of the oxygen of the nitric acid upon the combustible body. 2ndly. Concentrated sulphuric acid, poured upon a nitrate in a solid form, decomposes it in-

* The nitric acid is composed of a great quantity of oxygen, and a certain proportion of azote. It may likewise be considered as composed of deut-oxyde (nitrous gas), and of oxygen.

stantly, and sets at liberty the nitrid acid, in the form of white vapours, not very thick.

541. Nitric acid produces no turbidness in water saturated with sugar.

542. When mixed with a strong infusion of tea, the colour becomes deeper in proportion as the acid is added.

543. Burgundy wine is not precipitated by nitric acid; it only acquires a redder colour. A mixture of four parts of this wine with one part of the acid of commerce, presents no alteration on the addition of copper filings: not a single bubble of nitrous gas escapes if the experiment be made at the ordinary temperature; but if heat be applied, the wine loses its red colour, and passes to a yellowish white; shortly after, effervescence takes place, the copper dissolves, and the liquor becomes of a very beautiful green colour; it is only towards the end of the operation, that a gas of an orange-yellow colour is disengaged, the smell of which resembles at the same time that of nitrous acid gas, and of nitric æther.*

544. Nitric acid gives no disturbance to vinegar, neither does it lose any of its properties by being mixed with this fluid. If it be required to determine its presence in such a mixture, we must begin by saturating the liquor with pure potash; it should then be evaporated to dryness, and the product treated with highly concentrated alcohol: this menstruum easily dissolving the acetate of potash, and some other principles of the vinegar, and exerting no action upon the nitrate of that base, this will consequently be found to form part of the residue. The nitrate of potash in this residue may be easily detected, 1st, by throwing a part of it upon burning charcoal (§ 540.) 2ndly, by treating the remaining por-

* The same wine heated with copper alone without the addition of nitric acid, does not change colour, and neither effervescence, or the formation of any coppery salt is observed.

tion by concentrated sulphuric acid, which would disengage white vapours of nitric acid, or orange-yellow vapours of nitrous acid. The formation of this last gas may easily be conceived, if we reflect that the residue in question often contains, beside the nitrate of potash, a greater or less proportion of the muriates which formed part of the vinegar. Now, concentrated sulphuric acid, poured upon the mixture of a nitrate and a muriate, sets at liberty both these acids, which quickly act upon one another, giving rise to oxygenated muriatic gas (chlorine), and nitrous gas of an orange yellow.

545. Nitric acid, poured into albumine, produces immediately a white precipitate in great abundance, which after some time becomes yellow; in which the presence of nitric acid can be demonstrated by means of alcoholized potash. In fact if this yellow mass be perfectly washed, and after being dried upon the filter, be made to boil with a solution of pure potash, the liquor will all at once become of a rich red colour, and will furnish by evaporation, a brown red mass, composed of animal matter, nitrate of potash, and excess of the alkali employed. This mass, heated with concentrated alcohol, yields to this menstruum after a few minutes' ebullition, the animal matter and the potash, and there remains a portion of the nitrate of this base, the nature of which may be easily determined by paying attention to the properties laid down in § 540. The importance of these details will be felt, if we reflect that all the animal matters with which the nitric acid enters into combination, not excepting the organic texture corroded by this acid, act precisely in the same manner, and enable the practitioner to discover the poison, in cases where it would be impossible to do so by any of the means hitherto proposed.

546. The solution of gelatine is not disturbed by nitric acid.

547. Milk mixed with this acid, is instantly coagulated, and throws down white curds, which quickly change to yellow.

548. Human bile brought in contact with two drops of this acid, furnishes an abundant precipitate of *yellow matter*, which acquires a green colour by the addition of a fresh quantity of acid; and which in the end becomes of a brick red, when a great quantity of nitric acid is employed.

549. Fluid blood is instantly coagulated by the action of this poison.

ACTION OF NITRIC ACID UPON THE ANIMAL ECONOMY.

550. This poisonous substance, possessed of a corrosive property extremely energetic, acts upon the animal economy with a tremendous rapidity, producing the most serious symptoms, succeeded almost constantly by death. A number of experiments place this truth beyond all doubt.

1st. Twenty-six grains of nitric acid of commerce, mixed with ten grains of distilled water, were injected into the jugular vein of a robust dog, above the middle size. Immediately after, the animal experienced a considerable agitation in his limbs; he uttered plaintive moans, and died in the space of two minutes. He was opened immediately: the flesh was palpitating; the beating of the heart was hardly sensible; the blood contained in the left ventricle consisted of two great clots of a gelatinous appearance, of a blackish red colour, floating in a small quantity of fluid blood of the same colour: the arteries also of the thorax contained blood not coagulated. The lungs were of a rose colour, and but little crepitating.

2nd. Nitric acid was introduced into the stomach of several dogs whose œsophagi were tied in order to prevent vomiting. They died at the expiration of two, three, or four hours, with the same symptoms as those we have described in giving the history of sulphuric acid (vide § 531).

On opening them, the stomach was found corroded, and disorganised in some points, without however our being able

ever to detect any shades of yellow. The duodenum presented a lining of *yellow matter* proceeding from the decomposition of a portion of bile (vide § 548).

These facts evidently prove that the nitric and sulphuric acids occasion death by an action in every respect similar (vide § 541).

M. Tartra, in his beautiful work on nitric acid, has given a great number of experiments upon dead bodies, the results of which deserve to be explained here, as completing the solution of the problem which we are upon.

1st. Two ounces of nitric acid were introduced into an empty stomach, isolated from the body, and still attached to the œsophagus—it was left there during twelve hours: there were disengaged, a great quantity of nitrous gas, afterwards azotic gas, and carbonic acid: the great extremity of the viscus and its long curvature exhibited very broad spots, which, at the same instant, appeared white on the exterior surface of the organ, and shortly after became yellow. At the end of several hours the extent of these spots was greatly augmented; the coats of the stomach, which were become very yellow within and without, had a greasy appearance: within this viscus were found about two ounces of a liquid substance extremely thick, of a beautiful yellow colour, formed almost entirely of the nitric acid weakened. When the acid was allowed to remain in the stomach for four days, this viscus was in some measure dissolved; it went to pieces on the slightest touch; it could easily be reduced into a kind of greasy paste of a very beautiful yellow colour, capable of producing a speedy oxydation on iron and copper by its contact.

2nd. A quantity of pure water, wine, brandy, milk, broth, &c. were introduced into the stomach; after which were added two ounces of nitric acid: this corrosive, remarkably weakened, exerted an action much less energetic; as it was diffused over a greater number of points; almost the whole of the internal coat appeared to be affected: it had acquired

a yellow tinge, appeared to be slightly thickened, felt unctuous under the finger, and separated easily from the external membranes.

3rd. Before introducing the nitric acid into the stomach, it was filled with solid substances resembling food: the action of the acid was divided between the solid alimentary matter, and the coats of the stomach: sometimes even it has exerted the greatest action upon the extraneous substances, and frequently it has produced upon this organ only a slight yellow spot, and that sometimes confined to the mucous membrane.

Other experiments tried upon living animals, have led M. Tartra to conclude,—1st, that the nitric acid introduced in small quantity into the alimentary tube, combines immediately and entirely with the animal texture; 2ndly, that in a stronger dose, it acts in the same manner at the moment of the first contact, but remains for the most part in the stomach, where it is then without combination, and becomes weakened; 3rdly, that in this last case, it continues to act till it completely disappears, which happens insensibly in the course of a few hours, and always with more rapidity than in the dead body, on account of the very remarkable influence of the living state of the gastric organs, and particularly of the accelerating property of the animal heat.

SYMPTOMS OF POISONING BY NITRIC ACID.

OBSERVATION 1st.

Aubry, a woman of five and thirty years of age, swallowed, for the purpose of destroying herself, two ounces of aqua fortis. No assistance was given her in the first instance, and it was not till some hours afterwards that she was brought in the evening to the hospital.

The principal symptoms observed were, a countenance expressing a morose sadness, a state of continual anxiety, a

shivering all over the body, a small and almost imperceptible pulse, dull pains in the throat, and especially at the stomach; in the epigastric region they were extremely severe on the slightest touch; repeated retchings, and vomitings from time to time. *(White linctus. Solution of gum arabic with milk.)*

The surface of the body, and particularly the limbs, soon became cold; a greasy and icy sweat collected in large drops upon the surface of the breast; the patient expired about twenty-four hours after her admission to the hospital.

The interior of the mouth was remarkable for the injury sustained by the mucous membrane, which was thickened and appeared white, in some places slightly yellow, and came away easily in small pieces. The epidermis in the same manner separated from the edges of the lips, in a semilunar space, which was tinged with yellow, the line of which exhibited the print of the glass from which this unfortunate wretch had drank the poison. The tongue, the roof of the mouth, and the *velum palati* might easily be deprived of the whole of their mucous membrane, which was already detached in several places. Underneath this no remarkable alteration could be detected, except an unusual dryness. The throat presented the same appearances as the mouth, but in a much higher degree.

The œsophagus in its interior exhibited a grained lining, apparently cretaceous or rather greasy, of a fine orange colour, and having a dry surface totally destitute of mucosity. This crust of the œsophagus, on which was drawn a kind of folds, or furrows in a vertical direction, and which formed a sort of case introduced within the canal of the œsophagus, adhering very little to it, except in a few points, was no other than the mucous membrane itself, which had been changed in a remarkable manner by the nitric acid; this cylinder, which appeared of an albuminous nature, being removed, the rest of the coats of the œsophagus appeared to

be nearly in their natural state, only a little brown. The peritonæum, the intestinal canal, and the other parts, exhibited a dirty yellow colour.

The stomach was greatly distended, and covered with black spots; it contained a great quantity of gas, which was not fetid, and a turbid, yellow, flaky, and greasy fluid, one part of which, more dense than the rest, seemed attached to the internal surface of the stomach, and formed a kind of grained coat of various thickness, and of a greenish yellow colour. In the bottom of the stomach, opposite the cardiac orifice, were observed several irregular black spots, with such a morbid puffiness of the texture of the organ, that it resembled an animal substance strongly cauterized and burnt. Similar spots, but somewhat smaller, were found in the neighbourhood of the pylorus.

The interior of the duodenum and of the jejunum were lined with a very thick, yellow, and seemingly greasy coat, in every respect similar to that in the stomach.

OBSERVATION 2nd.

Motet, a painter, thirty-two years of age, a bachelor, formed the design of poisoning himself. He therefore bought, of a grocer-druggist, two ounces of a very highly concentrated nitric acid, which he swallowed at one draught on the 28th Germinal, at two o'clock in the afternoon. He had neither eaten or drank that day. Inexpressible pains in a short time announced the action of the nitric acid. The unfortunate man instantly rolled himself upon the floor of his chamber, nor could he any longer keep himself in bed. Vomitings came on, accompanied by a general sensation of cold, which was most remarkable in the extremities.

The matter vomited, boiled up and hissed each time it fell upon the pavement of the room. A physician who was called in, gave him some soap and water, and oil. At four o'clock

the man was transported to the great Hospital d'Humanité. He vomited several times by the way, and they stopped from time to time to give him drink. On his arrival, the first thing done was likewise to give him some diluting drink in considerable quantity, especially a decoction of linseed.

He was then in a state of continual agitation, with his countenance very much altered; he vomited every instant a blackish, glairy fluid; he opened his mouth with tolerable facility, the tongue was white bordering a little upon yellow; sharp pains were felt in the throat, along the œsophagus, and in the stomach; the belly, which was somewhat distended, could not bear the least contact without a considerable increase of the pains; the cold of the surface of the body was increasing, the pulse small, concentrated, frequent; with hiccup and difficulty of breathing.

The rapid march of the symptoms, far from relaxing, appeared to gain fresh strength every instant. The unfortunate wretch could not conceal the regret he felt, at having attempted his own life. In his violent agitation, he constantly uttered complaints accompanied with deep sobbings. His limbs became cold as ice, a cold sweat bedewed the whole body, the pulse was almost imperceptible; the pains did not cease for one single moment; all the phenomena were of the most alarming kind, and announced impending dissolution. The patient made incessant efforts to satisfy the pressing want which he felt to go to stool, or to make water; he begged for assistance from every person he could see, and from all those that surrounded him.

This frightful scene continued the whole night: the matter vomited became clearer, and of a citron colour; a few drops of urine at length forced their way. The hideous aspect of the body of this unfortunate wretch, already resembled that of a corpse, his senses were preserved unimpaired; and his imagination appeared enlivened. In his last moments a few spoon-

fals of an anodyne draught were administered to him. He still spoke the next morning, at the moment of his dissolution, which was nineteen hours after swallowing the poison, and sixteen after his admission into the hospital.

On opening the body it was ascertained that the action of the poison was confined to the organs of the *primæ viæ*. The coats of the pharynx, œsophagus, stomach, duodenum, and the superior half of the jejunum, were increased in thickness and consistence, and presented a very deep red colour on their external surface. The internal surface was for the most part encrusted with a coating more or less dry, and grained, of about two lines in thickness, of a greenish yellow colour, very fine and bright, which became tarnished by exposure to the light.

The *valvulæ conniventes* of the duodenum were greatly developed, and closed up the passage of that intestine.

OBSERVATION 3d.

Marie Roger, aged thirty-five years, a woman infamous for her bad conduct and debauchery, was brought to the great Hospital d'Humanité, by some soldiers of the guard, on the 23rd Pluviose, year 9, at one o'clock in the morning. A vague information was obtained of her having swallowed poison; she presented however few signs of poisoning. On being questioned as to what had happened to her, we learned, that about three in the afternoon she had been with her brother-in-law in a brothel, who had caused her to swallow eight pennyworth of *aqua fortis* in some white wine, and afterwards made her drink a great deal more white wine, and various spirituous liquors.

She was only brought in ten hours after the accident, and had as yet received no assistance. According to her own report, the pains in the throat and at the stomach had been extremely severe, and she had vomited a great deal from the first moment.

When this woman was brought in, she did not appear to be very ill: she sat down of herself on a bench whilst her bed was making, and afterwards stepped into it and lay down without assistance. Some vomitings still took place till five o'clock in the morning. The surgeon of the watch found her suffering so little pain, and thought the symptoms so slight, that he considered the suspicion of poison to be without foundation. He ordered her an antispasmodic draught, in which were thirty drops of sulphuric æther, and two drachms of the syrup of diacodium; and for her drink, barley-water with milk.

At eight in the morning a very attentive examination of the patient took place: her lips were white, as well as the interior of her mouth, and tongue; there existed a general languidness with lassitude of all the limbs. Shortly after, the tongue became dry, the pulse imperceptible, repeated horripilations took place, with a sensation of cold on the surface of the body, and especially of the limbs; a pressing desire to go to stool, with obstinate constipation, anxiety, and melancholy appearance.

The physician who had the care of her, doubted whether she was poisoned, and particularly with nitric acid: he thought to perceive in her situation the characters of an *adynamic* fever: he ordered her an antispasmodic draught, and diluting drink, such as a solution of gum arabic, and milk with barley-water. The want of any very considerable alteration in the inside of the mouth, the absence of the pains, the lassitude she felt in the limbs, and the prostration of strength, gave rise in a great measure to this opinion. No alteration took place till the following day: at one o'clock after noon, she got out of bed by herself to go to the close stool: an hour after which she expired, as we may say, suddenly, grasping with considerable force the arm of a person who was attending upon her, and crying out, "I am dying."

On examining the body, the first thing observed was the

firmness of the flesh, and its freshness: signs of a violent death. The cellular texture was filled with a very compact fat; the epidermis of the middle part of the edge of the lips appeared thickened, yellow, and partly detached.

On opening the abdomen, more than a pint of a yellow fluid of the consistence of pus, flowed out, which contained flakes more or less solid, of the same colour, which were spread all over the cavity of the belly, and which had a very pungent smell, similar to that of æther.

The peritonæum, which was become thicker, was greatly altered in several places, inflamed, and bedaubed with flakes of concrete albumine, of a very yellow colour. It presented numerous points of adhesion with the great curvature of the stomach, and bands connecting them, which were doubtless the result of inflammation of the interior of the abdomen.

The left lobe of the liver, which was deeply tinged with yellow on the outside, presented a surface greasy and unctuous to the touch. In all other respects this organ was in its natural state. The gall-bladder, which was elongated into a cylinder, and extended to four or five fingers breadth, was very full, of a brown colour inclining to black. The stomach presented a remarkable change of form; on the right side in particular, it was disposed in a triangular shape: its direction appeared almost vertical, owing to the depression of its great curvature, superior to which by two or three inches, the pylorus rested in contact with the gall-bladder. This organ, which was become horny and firm in certain places, was throughout almost its whole extent of a brown colour: its vessels, which were greatly injected, were distended with coagulated blood.

The whole of the abdominal viscera formed but one mass, in consequence of the adhesions produced by inflammation of the peritonæum, and the interposition of albuminous depositions. At first sight the intestines appeared sound, or nearly so, except the jejunum which had subsided, and was blackish, and very soft; the peritonæum which covered it was greatly

injured, and could be easily detached. The transverse arch of the colon was untouched; but it contained some very hard fæces. The duodenum was found to be attacked with gangrene in both its curvatures, and in the whole thickness of its coats.

In the thorax was nothing remarkable, excepting that the inferior lobe of the left lung was distended with blood, inflamed on its surface, and adhering to the diaphragm, which was likewise in a state of inflammation. An effusion of about four ounces of a milky serum, filled with albuminous concretions, similar to those of the abdomen, had taken place in this part. This local inflammatory affection without doubt depended on the vicinity of the stomach, which was the principal seat of disease.

The internal membrane of the mouth, which was thickened, and slightly tinged with yellow, was detached with great facility. The tongue was very dry: the amygdalæ red and tumefied; the fauces for the most part inflamed; the œsophagus lined with a white substance, which was dry and apparently cretaceous or greasy. Its internal membrane, which was confounded in the thickness of this lining, was easily detached, and was marked by vertical furrows.

The stomach presented, in the bottom of its great extremity, three openings near to one another, of the size of a crown of three francs,* with the edges worn very thin, or rather dissolved. It was very thick and contracted through the rest of its extent. There were found in its cavity four solid bodies of about eighteen lines of extent on a square surface, and of five or six lines of thickness, of a greasy nature, and resembling shapeless pieces of tallow. This substance when exposed to heat melted like fat, and when brought in contact with the light of a candle, gave out a beautiful flame, very white.

A lining, or a kind of yellowish greasy paste, thickest to-

* About the size of an English half-crown piece.

wards the small extremity and pyloric orifice, covered the internal surface of the stomach, and concealed some broad gangrenous spots, lying near to one another, from the bottom of the great extremity to the small one. All its vessels were extremely distended with black and coagulated blood.

The interior of the duodenum was found exactly in the same state as the stomach, having a yellow lining, &c. When the *valvulæ conniventes* were exposed, they appeared to be all burnt. The beginning of the jejunum was greatly injured, and this injury went on regularly decreasing. From the middle of the ileon to the anus, the intestinal canal, which was perfectly untouched, contained no longer any yellow matter, as did the superior portion of the alimentary canal.

The fluid effused into the belly, and which, without doubt had passed through the holes of the stomach, was collected and kept. It appeared to be the result of a mixture of a portion of the nitric acid swallowed with the different drinks, such as milk, &c. Its penetrating and ethereal odour depended probably on the æther taken in the antispasmodic draughts. This fluid remained a very long time without undergoing any alteration, but at last a very complete putrefaction took place. (This observation, as well as the first and second, is taken from the monographe of M. Tartra.)

OBSERVATION 4th.

Victoire Pillet, aged twenty-four years, of a strong constitution, being desperate at seeing her lover given up to the most scandalous debauchery, was seeking for some time the means of destroying herself. Being persuaded that she could kill herself by swallowing tartar emetic, she took forty grains of it in 1812, which only produced abundant vomitings and copious stools. Broken down by misfortunes, this unfortunate girl had recourse to aqua fortis, the corrosive qualities of which she well knew. On the 6th of June, 1812, at four o'clock in the morning, being a fortnight after the first at-

tempt at poisoning, she swallowed at one draught an ounce of concentrated nitric acid, with which she had mixed about two drachms of sulphuric acid, *in order that the poison might handle her roughly;* such were her own expressions. Instantly after swallowing this powerful caustic, Victoire fell a prey to the most horrible symptoms, such as excruciating pains in the throat, and in the abdomen, a burning heat along the course of the œsophagus, and in the region of the stomach, continual vomitings of a blackish green and glairy matter, violent colics, constant anguish, and a well marked sensation of cold on the exterior of the body, &c. She was carried to the Hotel-Dieu at seven in the morning, and a drachm of calcined magnesia was immediately administered to her, mixed up in a glass of some emollient ptisan.

Scarcely had the patient swallowed this medicine, when she flew into a violent passion, and protested that she would take no more medicine, that would give her any relief; that she had swallowed nothing since the moment of taking the poison, with the idea of dying more speedily. She was however forced to take fresh doses of magnesia, and a very considerable quantity of mucilaginous drinks were given to her. We saw her for the first time at eight o'clock in the morning, four hours after the accident: she was in the following situation; the countenance pale, the vessels of the conjunctiva injected, eyes haggard and animated, yellow spots on the edge of the upper lip, the mucous membrane of the mouth of a white colour, inclining to citron; the tongue yellow, crusted, and furrowed; sharp pains in the throat; vomitings from time to time, of yellow and black matter mixed together: most violent pains of the epigastric region, and of the abdomen; constipation; pulse small, frequent, and concentrated; shiverings; coldness of the extremities; respiration rather accelerated; anxiety clearly perceived; no alteration in the intellectual faculties; a free exercise of the external senses and movements. *(Fifteen leeches to the epigastric region, gum water*

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edulcorated, three emollient and narcotic glysters.) At ten o'clock, continuance of the vomitings, which were particularly provoked by the quantity of the drinks; furious delirium, extreme agitation of the whole body, horrible sufferings, countenance red. At noon, difficulty of speaking, deglutition impossible, convulsive movements of the muscles of the face, pulse remarkably frequent, and small. She died at one o'clock.

Appearances on Dissection.—Extreme stiffness of the limbs, and especially of the lower extremities; every part of the mouth of a citron colour; the pharynx of a bright red, œsophagus very little injured; stomach enormously distended, presenting no remarkable lesion externally, filled with a yellow, flaky fluid: its internal surface of a cherry red throughout its whole extent, excepting towards the pylorus, where two small black spots were found, formed by extravasated venous blood; the vessels of this viscus very much dilated, and as if injected; the duodenum and jejunum covered with a thick crust, of a *canary-yellow* colour, easily detached; no perforation in the digestive canal, no effusion into the abdominal cavity; peritonæum very slightly injected; the other organs appeared in their natural state; the brain, and membranes covering it, presented no sensible alteration.

OBSERVATION 5th.

Marie Coteret, a polisher, aged 50 years, took on the 8th of January, 1814, a dram-glass full of nitric acid; at the same instant she felt a pain, and excessive burning in the mouth, throat, œsophagus, and stomach. About an hour after, she had two or three vomitings of liquid matter, of a mucous appearance and yellowish colour, and in small quantity. At the end of eighteen hours, she was carried to the Hotel-Dieu, without having received any assistance since the accident. She was made to drink a very great quantity of a warm infusion of linseed, which she quickly threw up, with

more matter similar to that she had already vomited, and which contained mucous flakes of a reddish colour, and quite thick.

The next morning, at the hour of the visit, her face was pale; her tongue, which was of the colour of saffron, exhibited crusts and furrows, was tumefied, and trembling, nor was it possible for the patient to put it out of her mouth; the palate, and other parts of the mouth, which were white, were traversed by red lines, the edges of the lips, and the forepart of the chin, on which the poisonous substance when taken, or when expelled, had fallen, exhibited the same yellow colour as the tongue; the breathing was sonorous, the voice extremely low, confused, and nasal; deglutition was almost impracticable; the head, stomach, loins, and abdomen, were extremely painful. The pains in the different regions of the abdomen were increased by the slightest pressure; the pulse, which was not very frequent, was rather hard and concentrated. *(Twelve leeches to the abdomen, followed by emollient fomentations; twelve leeches to the anus, julep of gum arabic, and three pots of barley-water, with gum arabic, and edulcorated.)* In the evening, the patient had a stool with a great deal of straining; no sleep during the night; continuation of the pains, but the patient did not greatly complain.

The next day (third of the disease) the pulse appeared rather less hard: the tongue a little less yellow at its base and on its sides; the centre appeared of a brown colour; pellicles of a whitish colour, seemed about to detach themselves from the lateral parts of this organ; pains in every part of the body. *(Gum julep, three pots of gum water edulcorated.)* During the night the patient had two stools, and did not sleep.

The following day, (the fourth of the disease) she was lying in a supine posture, the trunk elevated, and the limbs extended, the eyes dim, countenance pale and cadaverous excepting the most prominent parts, which were injected and

livid; tongue of the natural colour, moist, and clean, except towards the point; respiration much more frequent than last evening, laborious, and sterterous; pulse less, and much more frequent; heat of skin natural; the patient nevertheless had a shaking all over the body. *(Orange julep.)* All drinks were returned through the nostrils, whatever were their nature or quantity. She died on this day at one in the afternoon.

Dissection, Twenty Hours after Death.

The limbs were remarkably stiff; the viscera, as well as the whole surface of the body, were still hot; although the temperature was at 5° below zero, and the body had been placed upon the stone pavement, from the moment of her decease. The two jaws were so firmly locked together, that they could not be separated but by great exertions, and by cutting all the organs destined to the purpose of closing them. The interior of the mouth, the tongue, and palate, were extremely pale; a serous kind of mucus in tolerable quantity covered the fauces: the superior third part of the œsophagus presented nothing very remarkable; in all the lower part of its extent it was dried, and tinged of a green colour. The stomach, which was blackish on its exterior surface, was so contracted, that it was with great difficulty a finger could be introduced. On opening it, it was found to be empty; its coats were inflamed, thickened, hardened, and puffed up, especially near the great extremity; they were of a deep brown red inclining to black; the points the most inflamed were of the colour of charcoal; the mucous and muscular coats were in some places destroyed, and the serous coat, which alone remained, might be pierced with the greatest ease. The pylorus was obliterated. No alteration in the duodenum. All the other organs appeared to be in their natural state. (Observation communicated by M. Rozier la Cardoniere.)

551. We cannot better trace out the symptoms of poison-

ing by nitric acid, than by borrowing the description given of them by M. Tartra, in his excellent dissertation, which we have already quoted several times.

Instantly on drinking the nitric acid, a burning heat is felt in the mouth, œsophagus, and stomach, with an acute pain, disengagement of gas, and abundant eructations,* retchings, hiccups, increasing pains in the throat, and in the epigastric region. In a short time repeated and excessive vomitings of a liquid, and sometimes a solid matter, which produces a kind of effervescence or boiling upon the ground. The peculiar smell and taste of the matter vomited, extremely perceptible to the patient, and to the observer; this smell and taste continue during the intervals of the vomiting, and even when it has altogether ceased, or from any cause has not taken place; tumefaction of the abdomen; considerable tension and exquisite sensibility, when touched ever so lightly; sensation of cold on the surface of the body, horripilations from time to time; the limbs sometimes of an icy coldness, particularly the legs and thighs; pulse small, tight, sometimes very frequent, and under certain circumstances, tremulous; horrible anxiety, continual agitation, contortions in every direction, inexpressible anguish, the weight of the bed-clothes insupportable, prolonged watchfulness; epigastric region swelled, and hard to the touch, excessive thirst; painful sensation every time the patient takes the smallest quantity of drink, pain often excruciating, a sense of corrosion, sometimes simple gripes; in some certain cases the pains obtuse, and very slight, with little or no agitation; this is a deceitful calm, either the effect of moral constraint, or of the high degree of internal disorganization, and is an illusory appearance of amelioration.

Deglutition difficult, tenesmus, obstinate constipation, desire to pass urine, without the power of satisfying it; features re-

* These depend on the disengagement of nitrous gas, and azotic gas, in the interior of the alimentary canal.

markably altered when the pains are excessive, bearing the impression of the most acute sufferings, and of the deepest affection of the mind; paleness, weakness; breath extremely fetid; in some instances the face of a lead colour; cold sweats, which are adhesive, unctuous, and greasy, collected in large drops; frequently a kind of obstruction, or obliteration of the throat: interior of the mouth and fauces of a dull white colour; the internal membrane thickened, and as it were burnt; surface of the tongue very white, and, in some instances, of an orange colour; teeth sometimes vacillating, their *coronæ* grown yellow; impatience in throwing the arms out of bed, and sometimes wanting to get up.

At the end of three or four days, a partial detachment, or total exfoliation of the mucous membrane; rags of it hanging in the interior of the pharynx, impeding respiration and deglutition; altering the sound of the voice; the edge of each of the lips almost always marked with a curved line, which from the first moment presents a white, or slightly citron colour; sometimes yellow spots on the chin, fingers, &c. &c. The pulse becomes feeble, sinking, irregular, unequal, at times intermittent, mostly bad, constantly hurried.

The pains in the belly are a sign that the poison has descended into the intestines, or is diffused into the abdominal cavity, by perforations effected in some part of the alimentary tube. M. Tartra thinks he is able to draw this conclusion from the facts he has observed; that when a small quantity of the nitric acid has been swallowed, the pain is in general very severe; and that when a great quantity has been taken, it is less intense. In the first case the caustic appears to act only according to the breadth of the space it occupies, and cauterizes only the thickness of the mucous membrane; the branches of the nerves are only injured in part, and they are violently irritated. In the second case, on the contrary, the whole is struck with death; the nerves are destroyed, and disorganized. From these considerations it follows, that the absence of pain is a bad sign.

The *vomitings* are exceedingly frequent, when the pains are severe; for then the stomach, being highly irritated, endeavours to disencumber itself of its contents, and puts on a continual spasmodic movement. If this viscus is perforated in holes, so that the patient complains of no pain, no vomiting takes place; both liquids and solids pass through the stomach, now perforated, and deprived of its vitality, and are effused into the cavity of the abdomen.

The *sensation of cold* is a phenomenon which takes place in several kinds of poisoning, but is particularly remarkable in that of which we are now treating. It continues a very long time, and is generally found, in whatever way the affair may terminate.

This disease may terminate,—1st, by a speedy death in the course of a few hours: 2nd, by a death which does not take place till some time after the poisoning: the patient goes off insensibly; he vomits at different times, scarified membranous portions, which sometimes retain the form of the stomach or œsophagus: these exhale an insupportably fetid smell: digestion becomes particularly painful, and constipation is prolonged for months together. 3rd. The patients drag on a miserable existence during the remainder of their life, experiencing from time to time, pains and burnings intolerable. In speaking of these persons, Zacchias has said: *Venena nisi occidant, relinquunt semper aliquam noxam, et morbos diuturnos.* 4th. By a complete cure.

LESIONS OF TEXTURE PRODUCED BY NITRIC ACID.

552. When persons die a short time after the ingestion of this acid, the following appearances will be observed: a colour more or less orange, of the epidermis on the edge of the lips, which has the appearance of being burnt, and is very easily detached; internal membrane of the mouth of a white

colour, frequently citron; the teeth are generally loose, exhibiting on their *corona* a very distinct yellow tinge; inflammation of the mucous membrane of the fauces and pharynx; on the surface of the œsophagus, a coat of yellow matter, greasy to the touch, which appears to be formed both of concrete albumen, and of the mucous membrane itself, but altered in a very peculiar manner; inflammation more or less violent of the stomach, more particularly towards the pylorus, and the beginning of the duodenum; sometimes grangrenous spots in the coats of these organs, which likewise exhibit a net-work of blood-vessels, apparently multiplied, dilated, and filled with black and coagulated blood; they are worn thin, as if dissolved, and are ready to tear on the slightest touch; a thick grained coat, like a paste, of a greenish yellow colour, lines the interior of these viscera, which contain a great quantity of a yellow matter, of the consistence of a thick soup, in which there are flakes resembling tallow; the folds of the stomach are very brown, and reduced to a mucilage; the pylorus very much contracted; the coats of the duodenum and jejunum spotted with yellow, sometimes inclining to green: these injuries of the parts diminish in proportion to the distance from the stomach; the great intestines generally filled with fæces very hard, and moulded; peritonæum thickened, hard, of a dirty red colour, covered with albuminous concretions, which unite all the viscera together, by very numerous adhesions; in some instances, very considerable distension of the stomach; in others, this viscus is reduced to a very small bulk, which generally is the case where it has been perforated; then, a considerable effusion takes place into the abdomen, of a thick, yellow, and flaky fluid; inflammation more or less considerable and general, of all the abdominal viscera, as well as those of the thorax; sometimes yellow spots upon the hands or other parts: these are produced by a small quantity of nitric acid being dropped from the vessel, out of which the poison had been drank.

All that relates to lesion of texture produced by the nitric acid, in those persons who have not died till a long time after taking this poisonous substance, we shall refer to the history of slow poisoning.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY NITRIC ACID.

FIRST CASE.

The Person is dead: the Remainder of the Poison can be procured.

553. A. If the nitric acid be without mixture, a few drops of it are sufficient to distinguish it from all other corrosive substances. We should begin by letting fall a single drop into the infusion of tournesol; if this test be reddened, the poison must be tried by copper filings, which will be converted into a nitrate of copper, of a blue colour, and orange-yellow vapours will be disengaged; lastly, it should be saturated with potash, and the result evaporated; and if it act with fire, and with the sulphuric acid, as nitrates do, it may be decided that the subject of the experiment is really nitric acid. If the quantity be considerable, the remainder should be mixed with charcoal, phosphorus, or sulphur, in order to obtain, by ebullition, the orange-coloured vapours of the nitrous acid gas, (vide § 538). Amongst the signs which best serve to point out this kind of poisoning, we ought to pay particular attention to the yellow, citron, or orange-coloured spots which may be perceived upon the chin, lips, and hands: the state of the interior of the mouth will also frequently furnish data by which the cause of the symptoms to which the patient has fallen a prey, may be ascertained.

B. If the nitric acid has been taken in wine, vinegar, tea, &c., we must proceed to the analysis of these fluids, accord-

ing to the rules described at large in § 543 and 544. The physician will keep in view, that it is impossible to decide upon the existence of the nitric acid in these kinds of mixtures, unless by obtaining a nitrate by the addition of an alkali, and orange-yellow vapours of nitrous acid gas, by boiling it with copper filings.

SECOND CASE.

The Person is living: all the Poison has been swallowed: the Matter vomited can be procured.

554. The relation of the case, the evidence of the assistants, the actual state of the patient, the chemical examinations of the fluids vomited, are the resources which the practitioner must avail himself of in these circumstances, which are almost always embarrassing. The matter vomited exhibits a variable colour; sometimes it partakes of the yellow tinge which the animal or vegetable substances affected by the poison impart to it; sometimes it is rendered green by a portion of the resinous part of the bile *(green matter)*, set at liberty in the stomach by the nitric acid: sometimes also its colour approaches to red: the falling of this matter upon the hearth, or ground, almost always produces ebullition or effervescence, owing to the disengagement of carbonic acid gas from some carbonates, which are decomposed by this powerful caustic. These are sufficient to shew the importance of observing correctly the principal physical qualities of the liquids vomited, before proceeding to their analysis.

A. We must begin by examining the fluid part, which commonly floats over the food or texture which have been decomposed; this must be poured off; and if it should not be in sufficient quantity to be easily separated, the whole must be pressed through a fine piece of white linen, and the liquid part should be tried with the tincture of tournesol, copper filings, and caustic potash. If these three tests act in the manner we

have described § 553, B, it may be concluded that it contains nitric acid. It may happen, from being combined with too great a quantity of water, that the mixture will not exert any action upon the copper at the ordinary temperature. In this case it must be heated to ebullition, in order that the metal may decompose the nitric acid, when brought to a suitable degree of concentration. It is easy to conceive, that this method will always succeed, whilst there remains a portion of acid, not combined with the alimentary matter, and this is the case which most frequently occurs.

B. If the nitric acid, from its combination with albumen, muscular flesh, or various other aliments, has been rendered insoluble, and consequently it cannot be found in the decanted or expressed portion, it must be sought for in the flaky and other solid substances. For this purpose they must be put into a phial, and made to boil for three quarters of an hour, in a solution of pure potash. The liquor, which will be of a colour more or less red, must be filtered, and evaporated in a capsule of porcelain. The mass thus obtained, being boiled with a sufficient quantity of concentrated alcohol, will leave a residue consisting principally of nitrate of potash (vide § 545). There can be no doubt in this case that the nitric acid was combined with alimentary substances. The juridical physician will not be able to decide on the presence or absence of this corrosive, until he shall have submitted the matter vomited to the different experiments we have just detailed.

THIRD CASE.

The Person is living: the whole of the Poison has been swallowed: the Vomitings cannot be procured.

555. The practitioner in this case can gain no information from chemistry.

FOURTH CASE.

The Person is dead.

556. The nitric acid is perhaps the only poison of the mineral kingdom, which destroys life by producing lesions of a particular nature, so as to render it possible sometimes to recognise it by the simple examination of the dead bodies. The yellow tinge which it communicates to the lips, chin, and a great portion of the digestive canal; the conversion of the mucous membrane into a greasy substance, the perforations of the stomach, and effusion of a muddy yellow fluid into the abdomen, are so many characters, which are only found together where they have been produced by this acid; and it may be affirmed that, if all the patients who have fallen victims to its action, constantly exhibit the whole of these appearances, they should be sufficient almost to decide with certainty, that the poisoning has been the consequence of the ingestion of aqua fortis. This explanation will suffice to make it appear how important a matter it is, that the practitioner called upon to examine a body suspected to have been poisoned by the nitric acid, should examine attentively the different lesions of the digestive canal, and other organs. If these lesions should be the same as we have just described, and the chemical experiments made upon the contents of the stomach, furnish results agreeable to the principles laid down in § 554, it may be decided that the poisoning has been the consequence of nitric acid. In case the organic lesions should present a character different to what we have described, far from excluding the idea of the possibility of poisoning by aqua fortis, the greatest care ought to be employed in the search, to discover whether the nitric acid does not form a part of the solids or fluids contained in the stomach, or whether it be not intimately combined with the texture of this viscus; in this troublesome examination, what we have delivered concerning

the analysis of the matter vomited (§ 554), will serve for a guide.

TREATMENT OF POISONING BY NITRIC ACID.

Does there exist any antidote to the nitric acid?

M. Tartra says in his dissertation, that the quantity of nitric acid remaining at liberty in the stomach, may be neutralized in a manner more or less favourable to the preservation of animal life, according to the promptitude of the administration of an alkaline solution, of strong soap and water, or pure magnesia suspended in water.*

I have tried a great number of experiments upon living animals, with the design of determining to what degree magnesia might be considered as an antidote to nitric acid. The animals submitted to these experiments were placed under the same circumstances as those which had taken the sulphuric acid, and furnished results precisely similar. Those to whom two drachms only of nitric acid, were given, diluted in three or four ounces of water, suffered a great deal more, and lived much less time, than those which had been made to swallow the same dose of nitric acid, without any addition of fluid, and to which, three, four, or six drachms of magnesia, suspended in a little water, had been given. This earth then appears to be capable of diminishing the effects of nitric acid, provided it be employed a short time after the ingestion of this corrosive.

M. Desgranges has reported, in the *Journal de Médecine* a fact which corroborates the results obtained by us.

OBSERVATION.

A mechanic, thirty-six years of age, swallowed in a moment

* Op. Citat. p. 113.

of despair, more than half a glass of aqua fortis. He quickly felt a great heat and considerable irritation in the throat, and down to the stomach. The excitement produced in the stomach, occasioned the greatest part of this fatal fluid to be returned by vomiting; or at least, all its superabundant parts which were not employed in corroding the parts with which they had come in contact. M. Desgranges, who was instantly informed of the circumstance, found him vomiting with efforts almost convulsive. The water which had been given him, was returned strongly impregnated with acid, and set his teeth on edge to a very painful degree. The internal pains were extremely acute, and gave the idea of tearing and erosion. A drachm of pure magnesia, suspended in half a glass of sugared water, was immediately administered, and at the same instant the patient felt himself relieved. The vomiting however very soon returned, but with less fatigue and exertion of the injured parts; half a drachm more of the same remedy put a stop to them altogether. He was afterwards made to take a scruple every half hour, and in less than three hours the patient no longer suffered any pain; he still retained some sensibility in the region of the stomach, but nothing acute, or tearing: he affirmed, that at each draught of the *drink whitened* by the magnesia, he felt as if a kind of mucus, or, to use his own expression, a *coat of velvet*, had lined all the corroded parts, to his great relief, and thus weakened the extreme sensibility, and chased away the pain.

The next day, a swelling and considerable tension were discovered within the throat; the outside was equally swelled, respiration was impeded, deglutition rendered painful, and almost impossible, and numerous burnt sloughs appeared at the bottom of the mouth. He was twice bled in less than twelve hours, once in the foot; his glysters were made more purgative, the first having remained without any effect; at the same time a tolerably strong dose of *ol. ricini*, was given in a white linctus. The evacuations which followed, produced

an amendment in the symptoms, which gave confidence to the patient. Towards the sixth day, he complained of an increase of heat and of agitation; towards night a sort of miliary eruption appeared on the skin, attended with great itching. Diaphoretics sweetened with honey, and drank copiously, served to make it disappear.*

Many physicians have recommended the exhibition of potash and soda as antidotes to aqua fortis: the caustic and irritating properties of these alkaline substances ought to cause them to be rejected; at least, unless they be diluted with a very great quantity of water, or that their corrosive property be neutralized by the combination of an oily body, as soap. This medicine, which is composed of oil and soda, has been often of great service in cases of poisoning by nitric acid; it easily decomposes in the stomach; the acid unites to the soda, and forms nitrate of soda, while the oil remains free.

Crab's eyes, powder of coral, prepared pearls, burnt hartshorn, chalk, and all the other varieties of calcareous carbonates, have been extolled and employed for arresting the progress of the murderous effects of aqua fortis. If no other substances are at hand, these medicines may be employed, as they possess the power of combining with this acid, and neutralizing it. They have however the inconvenience of disengaging too great a quantity of carbonic acid gas, which distends the stomach beyond measure.

558. Having examined the effects of the different substances capable of neutralizing the nitric acid in the stomach, we shall next trace out the steps which the practitioner ought to follow in the different cases of poisoning by this corrosive.

If the nitric acid has been taken in very great quantity, and there is reason to believe that a part of it remains free in the stomach, he should have instant recourse to calcined mag-

* Recueil Périodique de la Société de Médecine, rédigé par Sedillot, tom. vi. p. xiv.

nesia, which may be given in the dose of a drachm, suspended in a glass of water: at the same time, the patient should be made to swallow a quantity of sweet and mucilaginous drinks, in order to fill the stomach, and oblige it to evacuate the poison diluted with these drinks. As the vomiting takes place, the same dose of magnesia should be repeated, and the emollient drinks persisted in, such as linseed, or marsh-mallow tea, solution of gum-arabic, milk, broths, &c. In case of a want of magnesia, an abundant solution of soap and water should be employed. This remedy, on which Majault has cast a great degree of obloquy, may be administered by every body, without the assistance of the apothecary, and immediately after the accident; its use is beside perfectly free from danger: the rapidity by which it is decomposed by the nitric acid in the stomach is such, that it can neither inflame nor corrode the membranes of this viscus, as has been supposed by Majault. The medicinal soap ought to be preferred to that in common use, as being more soluble in water, more pure, and of a less disagreeable flavour. We should not hesitate to ply the patient well with water, until the medicines we have recommended can be procured.

Oil of sweet almonds, and of olives, administered in a very large dose, have sometimes been extremely useful in the first moments of this kind of poisoning, by procuring very copious vomitings.*

In cases where inflammation of the abdomen is made

* A young man was sent one day to an apothecary, to procure some cherry-water; the apothecary being accustomed to see this youth come for aqua-fortis, gave him by mistake the nitric acid, which the youth very hastily drank a spoonful of. The symptoms which succeeded quickly made known the mistake; the patient was immediately made to drink a very considerable quantity of oil of olives; very copious vomitings instantly took place, and the alarming symptoms in a short time were moderated, and were even made to disappear. (*Ephem. Curios. Natur. German.* tom. xiii. Obs. 134. p. 300.)

known by its usual characteristic symptoms, leeches must be applied to the parts affected, and general bleedings employed: these means however must be omitted where spasm or tension exist, or where one or more of the viscera are affected with gangrene.

Emollient glysters, warm baths to half the body, and fomentations, ought to be employed to arrest the progress of the inflammation produced by the caustic. Gentle narcotics are of great utility in destroying the spasm occasioned by the corrosion of the stomach. The theriaca so much boasted of as a general antidote, ought to be rejected in the treatment we are describing. All heating food and spirituous liquors ought to be carefully avoided. The patient should observe the most rigorous low diet.

559. If the nitric acid has been taken in a very small quantity, and there be reason to presume that it has wholly combined with the membranes of the mouth, throat, œsophagus, and stomach, the neutralizing method must be given up, in order to have recourse to emollients, which must be used in great abundance, conformably in every respect to the precepts we have just laid down.

PHYSICAL AND CHEMICAL PROPERTIES OF THE MURIATIC ACID.

560. Pure muriatic acid, is in the form of a colourless fluid, of an intolerable smell, and an extremely caustic acid taste; its specific gravity is, as 1,203, when in its greatest degree of concentration; it strongly reddens the tincture of tournesol.*

561. When exposed to the action of caloric in close

* The gaseous muriatic acid, is formed of equal parts in bulk, of hydrogen gas, and of oxygenated muriatic gas (Chlorine).

vessels, it disengages a great quantity of muriatic acid gas, which is colourless, very soluble in water, of a strong pungent smell, which excites coughing, reddens strongly the tincture of tournesol, and which exhales, on exposure to the air, a white smoke or vapour, very thick, owing to its instantaneous union with the water of the atmosphere, which forms anew with it muriatic acid diluted with water, and which precipitates.

562. The fluid and concentrated muriatic acid, brought in contact with the air, diffuses instantly, and from the same cause, thick and pungent vapours.

563. The fluid muriatic acid combines easily with potash, soda, barytes, &c. and furnishes salts easily to be known. 1st. All the muriates when dissolved in distilled water, give a white precipitate with the solution of nitrate of silver: the precipitate, which is curdled and heavy, dissolves in ammonia, and is not soluble in nitric acid: it consists of muriate of silver, and the super-natant fluid contains nitrate of potash soda, or barytes, &c. (vide page 23, note §). 2nd. When concentrated sulphuric acid is poured upon a solid muriate, a brisk effervescence is instantly produced, the salt is decomposed, and the muriatic acid disengaged in the form of white vapours, which are thick, and of an excessively pungent smell. 3rd. If instead of employing concentrated sulphuric acid, this acid be used diluted, and the muriate be mixed with some substance which easily parts with its oxygen, such as the oxyde of manganese (peroxyde), oxygenated muriatic gas (chlorine) will be obtained of a greenish yellow colour; and the muriate is likewise decomposed.

564. The fluid muriatic acid transforms the nitrate of silver into an insoluble muriate (§ 40).

565. It does not disturb lime-water, nor does its vapour corrode glass; characters which serve to distinguish it from the fluoric acid, to which it has in other respects some affinity.

566. When poured upon a soluble salt of lead, it decomposes it, and gives rise to a precipitate, which is white, heavy, and soluble in thirty or forty times its weight of distilled water.

567. When heated with the peroxyde of manganese, it forms deuto-muriate of manganese, disengaging oxygenated muriatic acid gas (chlorine) of a greenish yellow colour.

568. It causes no change in a strong infusion of tea, or in water saturated with sugar.

569. When brought in contact with red wine, and with coloured vinegar, the fluid muriatic acid produces no disturbance, the colour only becomes rather deeper. If it was intended to determine the existence of this acid, in these kinds of mixtures, it would be necessary to heat them in a retort to which a receiver was adapted: a few minutes' ebullition would be sufficient to volatilize the muriatic acid, which would become condensed in the balloon, and which might be recognised by the tincture of tournesol, and more especially by the nitrate of silver, which would precipitate it in the state of a curdled muriate, insoluble in water, and in pure nitric acid. Some writers on medical jurisprudence have recommended pouring nitrate of silver into wines and vinegars, suspected of being adulterated with muriatic acid: this method is faulty; for if these liquors contained any muriates, the solution of silver would act in the same manner as if they contained free muriatic acid. It is sufficient, in order to avoid this difficulty, to operate upon the fluid obtained, by distillation.

570. Fluid muriatic acid gives no disturbance to the solution of gelatine.

571. It precipitates albumine copiously in the form of white flakes.

572. Milk is coagulated in thick curds, in the same manner as by the sulphuric and nitric acids.

573. Human bile, mixed with a very small quantity of

muriatic acid, furnishes a copious precipitate of *yellow matter:* when a great quantity of acid is added, the colour becomes green.

574. Fluid blood is coagulated by a few drops of muriatic acid.*

ACTION OF MURIATIC ACID UPON THE ANIMAL ECONOMY.

575. This acid has the greatest analogy in its mode of acting, with those of which we have before spoken: 1st. When injected into the veins, it produces death suddenly, by coagulating the blood. 2nd. When introduced into the stomach, it produces in a very short time the most violent inflammation: the nervous system is affected by sympathy, and life is speedily extinct.

Experiment. When two or three drachms of fuming muriatic acid are administered to dogs of a middle size, they are observed suddenly to feel a great degree of uneasiness; they exhale, through the mouth and notrils, thick vapours of muriatic acid; in the course of a few minutes, they vomit a matter which is brown, greenish, stringy, and as it were bilious. They utter plaintive cries, and expire, four, six, or eight hours after the ingestion of the poison. Death is generally preceded by very violent convulsions, especially in the muscles of the neck and of the spine. In some cases these organs are so strongly contracted, that the head is bent backwards, and forms a curvature with the spine, the concavity of which is very remarkable. On dissecting the bodies, a deep injury is found in the texture of the stomach: sometimes the mucous

* The muriatic acid of commerce is never perfectly pure; it often contains sulphuric acid, oxygenated muriatic gas, and sometimes muriate of iron; for which reason it appears under a yellow, green, or reddish colour. These extraneous bodies, however, do not hinder it from acting as we have described, with the re-agents which are capable of detecting it.

membrane is inflamed, and of a cherry-red colour throughout its whole extent: sometimes the part of this membrane bordering on the pylorus, presents spots either black, or of a very dark red, which are true sloughs, and which might be taken at first sight, for a collection of extravasated blood upon the muscular membrane: lastly, at other times perforations are found in the places corresponding with these sloughs, and in that case there is an effusion into the abdomen of liquid matter, evidently acid. The other viscera do not present any remarkable alteration.

SYMPTOMS OF POISONING BY MURIATIC ACID.

OBSERVATION.

Louis Grenier, a stone-cutter, aged thirty-seven years, had a fall upon the head on the 7th of July, 1805, after which he felt occasional giddiness; two days after, he remained with his bare head exposed to the sun for several hours, and felt a violent head-ache. In the evening he became delirious, with a great degree of agitation. On the 10th, the agitation was more considerable, and the delirium furious. On the 12th, he entered the Hotel-Dieu; his face was animated, the eyes red, and sparkling; the delirium attended with violent agitation: pulse frequent, full, and tight. He was bled in the foot, which gave no relief.

The 13th. Delirium more violent, pulse less strong, and less frequent. *(Bleeding from the jugular vein; veal broth, and whey.)* Delirium continued after the bleeding.

14th. In the same state. *(Leeches to the neck; irritating bath for the feet with muriatic acid.)*

In the evening, agitation still greater, skin burning and dry, pulse small and concentrated, tongue fiery red, lips blackish, hiccup, efforts to vomit, excruciating pains in the epigastric

region. On examining into the cause of the terrific state of this patient, I learned from the nurses, that he had been made to swallow about an ounce and half of muriatic acid, under the supposition that it was whey they were giving to him. *(Powdered magnesia, edulcorated gum arabic.)*

In the night, vomitings of yellow matter. On the 15th, skin cold and clammy, violent pain in the epigastrium, pulse extremely frequent, continual delirium. He died at three in the afternoon.

Appearances on Dissection.—Lips black, tongue thickened, hard, and dry; pharynx and œsophagus of a purple red colour, excoriated in several places; stomach thickened, and inflamed on the outside. In the interior, the mucous membrane came away in pieces, with the greatest facility, throughout almost its whole extent, the great extremity exhibited gangrenous spots; the duodenum was likewise a little thickened; the jejunum was perforated by a *lumbricus*, which was found in the cavity of the abdomen.

The arachnoid membrane was thickened, and opaque; the pia mater was very much injected; there was found between the convolutions of the brain, a great abundance of serum; this viscus was greatly injected, and its ventricles distended.*

576. The symptoms produced by the muriatic acid, do not differ in any respect from those observed in the cases of poisoning by the sulphuric and nitric acids, for which reason we conceive it useless to enumerate them. It appears however that patients who have swallowed a certain quantity of it, emit, in the first moments of the accident, a thick smoke, of a white colour and very pungent smell.

* Observation communicated by Dr. Serres.

LESIONS OF TEXTURE PRODUCED BY MURIATIC ACID.

577. The lesions resulting from the action of this acid upon our texture, bear the greatest resemblance to those produced by the sulphuric acid. Redness of the mouth, pharynx, and stomach; extravasation of venous blood in some parts of this last viscus, sloughs, perforations in one part or more, are the principal injuries occasioned by it, and which are very seldom accompanied by any yellow colour, of the parts with which it comes in contact.

APPLICATION OF ALL THAT HAS BEEN SAID, TO THE DIFFERENT CASES OF POISONING BY MURIATIC ACID.

578. *A.* This acid is easily recognised when free from mixture, by the action which it exercises on the following re-agents; viz. Tincture of tournesol, potash, soda, or barytes; nitrate of silver, acetate or nitrate of lead, peroxyde of manganese. The vapour which it diffuses in the air, and the manner in which it acts with caloric, will likewise furnish sufficient proofs of its presence (vide § 560 et seq.).

B. If it were mixed with wine, vinegar, or any other substance incapable of rendering it insoluble, its existence would be easily demonstrated by distilling the fluids which contained it, and by treating the volatilized products found in the recipient, by all the re-agents of which we have spoken, § 569.

C. When the muriatic acid forms part of the insoluble matter vomited, or of that found in the digestive canal after death, we must have recourse to pure potash, perfectly free from any muriates. All these substances being heated with distilled water, and the alkali we have proposed, ought to furnish, after three quarters of an hour of ebullition, a fluid in

which nitrate of silver will demonstrate the presence of the muriatic acid, if this corrosive really formed any part of their composition.

TREATMENT OF POISONING BY MURIATIC ACID.

579. The experiments which we have instituted on different living animals, allow of drawing the conclusion, that calcined magnesia and medicinal soap are the most proper substances for neutralizing those parts of the poison, which are not yet combined with our texture. We ought then to have recourse to these medicines, from the first moment of the ingestion of the poison, without neglecting at the same time copious draughts of warm water, milk, broth, and different mucilaginous and emollient drinks. The anti-phlogistic and anti-spasmodic treatment must be employed in those cases where the violence of the symptoms would induce a fear of, or may have already announced, the inflammation of one or more of the organs; or spasm, convulsions, &c.

PHYSICAL AND CHEMICAL PROPERTIES OF PHOSPHORIC ACID.

580. This acid is solid, entirely destitute of smell or colour, and yields a very sharp taste. It is most commonly seen in the form of a thick liquid, almost viscid, of a specific gravity greater than that of water; it reddens strongly the tincture of tournesol.

581. When exposed to the action of caloric it dissolves, and forms a white and transparent glass. If the temperature is much elevated, it finishes by evaporating, provided the operation be performed in a crucible of platina, for vessels of earth, or of glass, are capable of combining with it, and preventing its volatilization.

582. The solid phosphoric acid, when pulverized with three parts of charcoal in a mortar of porcelain, and strongly heated in a crucible, decomposes in a short time, and gives out phosphorus, which quickly inflames; there is disengaged at the same time carbonic acid gas, or carbonic oxyde gas; which proves that charcoal is capable of carrying off the the oxygen from this acid, at a high temperature.

583. Water easily dissolves the phosphoric acid.

584. In this state it possesses properties which make it easily distinguishable. When poured into the water of barytes, strontian, and lime, it produces white precipitates, easily soluble in an excess of phosphoric acid, or in pure nitric acid: this last character prevents the phosphoric acid from being confounded with sulphuric acid, which furnishes with the water of barytes, a precipitate insoluble in nitric acid.

585. The liquid phosphoric acid, decomposes the solution of acetate of copper, and precipitates from it a phosphate of copper of a bluish white colour, which can easily be dissolved in an excess of the phosphoric acid.

586. It produces a white precipitate in the solution of proto-nitrate of mercury (*nitrate of mercury at minimum*). It does not at all disturb corrosive sublimate.

587. When mixed with a solution of muriate of tin of commerce, it renders it turbid, and separates from it a white precipitate, composed of oxyde of tin and phosphoric acid.

588. The deuto-muriate of gold, and sulphate of zinc, experience no sensible change from this corrosive.

589. When brought in contact with the acid proto-muriate of cobalt dissolved in water, it produces no disturbance; but if a small quantity of ammonia be added to the mixture, a beautiful rose-coloured precipitate is instantly seen, consisting of the proto-phosphate of cobalt. A few drops of alkali will decompose this phosphate, laying hold of the phosphoric acid; and the precipitate passes to the state of prot-oxyde of

cobalt, of a blue colour, inclining slightly to violet. It follows from this, that, in order to obtain the rose-coloured precipitate, it is necessary to employ only the quantity of ammonia required for the saturation of the free acids.

590. Sugared water and wine experience no disturbance from this acid.

591. The solution of gelatine becomes more transparent by its mixture with the phosphoric acid.

592. Human bile is decomposed by this acid, which causes an abundant precipitate of *yellow matter;* when a greater quantity is employed, the colour passes to a deep yellow, bordering on green.

ACTION OF THE PHOSPHORIC ACID UPON THE ANIMAL ECONOMY.

593. When a few grains of phosphoric acid are injected into the veins, dissolved in a very small quantity of water, the blood becomes coagulated, and the animal dies in the course of one or two minutes; if the acid be weakened, it does not experience any inconvenience. When introduced into the stomach, the phosphoric acid destroys life at the end of a variable space of time, according to the degree of concentration, and the dose employed.

Experiment. A small dog, two years of age, was made to swallow thirty grains of phosphoric acid, dissolved in half a drachm of water: in the course of two minutes, the animal vomited a small quantity of stringy and reddish matter; these vomitings were repeated four times, during the first fifty minutes after the ingestion of the poison. Two hours afterwards, he appeared to experience pains in the throat, and made many useless efforts to vomit. The next morning he was dejected and sorrowful, and remained lying upon his belly. He was placed upon his legs, in order to make him walk; but experienced such vertigoes, that it was impossible

for him to make two steps without falling. He died at noon, twenty-three hours after the poisoning.

Dissection. The mucous membrane of the stomach was of a deep red, principally in the part bordering upon the pylorus; the interior of the duodenum presented the same appearance: the lungs were sound.

We are of opinion, that the analogy existing between the mode of action of the phosphoric acid, and those whose history we have given, renders any further discussion of this subject unnecessary.

594. The history of the symptoms, lesions of texture and treatment of this kind of poisoning, would be a repetition of all that has been said in treating of the sulphuric and nitric acids. As for the application of it to medical jurisprudence, it will be sufficient for the practitioner to refer to what we have said in § 580 et seq.

OF SOME OTHER MINERAL AND VEGETABLE ACIDS.

There remains still a certain number of acids which are capable of producing symptoms more or less serious, when introduced into the stomach; we shall proceed to point out some of them, confining their history to the explanation of the means proper for distinguishing them, from those which we have already described. We shall not speak at all of their action upon the animal economy; nor of the symptoms produced by them, or lesions of texture; neither of the treatment necessary to be opposed to them, all these objects bearing a strong analogy to what we have said concerning the other acids.

OF THE FLUID NITROUS ACID.

595. This acid may appear under a blue, green, clear

orange-yellow, or deep orange-yellow colour, according as it is more or less charged with nitrous acid gas: it strongly reddens the tincture of tournesol, and acts with great force upon our texture. Its smell and taste are very remarkable.

596. Exposed to the action of caloric, it furnishes a great quantity of nitrous acid gas, of an orange-yellow color.

597. When poured into hydro-sulphurated water (*water saturated with sulphurated hydrogen gas,*) it instantly decomposes it, and produces a sediment of sulphur of a yellowish white colour; the hydrogen combines with a portion of the oxygen of the nitrous acid, and forms water: at the same time a disengagement of oxyde of azote, or of azote, takes place.

598. Copper, mercury, zinc, and iron, are attacked and dissolved by this acid, with the greatest energy; the solution is accompanied with effervescence, and a disengagement of a very great quantity of nitrous acid gas, of an orange-yellow colour.

OF FLUORIC ACID.

599. Pure fluoric acid is always in a fluid state; it is colourless; its smell is pungent and very penetrating; its taste is extremely disagreeable; it reddens very strongly the tincture of tournesol.

600. When brought in contact with the air, it emits white vapours extremely thick.

601. When mixed with water, it disengages a great deal of heat, and produces a noise similar to that of a red hot iron plunged into it, which depends upon the violence with which these two liquids combine.

602. It dissolves silex with facility; so likewise when a small quantity is put upon glass (a combination of alkali and silex) it instantly corrodes it.

603. The fluoric acid precipitates lime-water.

M. Thenard, who first discovered this acid in a pure state,

says: "it is of all bodies the most corrosive; it acts upon "the animal texture with great energy: scarcely is it applied "to the skin, when it is instantly disorganised; a severe pain "is quickly felt; the parts bordering on the point touched, "become white and painful, and form a thick blister, which "is filled with matter. Even when the quantity of acid shall "have been very small, scarcely visible, the same phenomena "take place; only a few hours would be required for their "production." *

OF THE SULPHUREOUS ACID.

604. This acid is limpid and colourless; its smell is pungent, and similar to that of burning sulphur: its taste is very peculiar.

605. When exposed to the action of caloric in a close vessel, it furnishes a very great quantity of sulphureous acid gas, which is colourless, and has the same smell as the fluid acid.

606. When brought in contact with proto-muriate of tin, dissolved in water, the fluid sulphureous acid is decomposed, and yields its oxygen to the salt, which it transforms into a deuto-muriate, and the sulphur is precipitated (vide p. 251. B.).

607. When combined with potash, soda, &c. it produces a sulphite, which may be obtained in a solid form, by evaporation. Concentrated sulphuric acid being poured upon this salt reduced to powder, decomposes it with effervescence; and disengages from it sulphureous acid gas easy to be distinguished by its peculiar odour.

* Traité de Chimie Elémentaire, tom. i. page 556, first edition, 1813.

OF THE PHOSPHOROUS ACID.

608. This acid is always fluid and colourless; it has a slight smell of phosphorus, and strongly reddens the tincture of tournesol.

609. When exposed to the action of caloric in a phial, it inflames at the end of a few minutes' boiling, especially when it is concentrated, and passes into the state of phosphoric acid. This extraordinary phenomenon depends on the water contained in the phosphorous acid being partly decomposed; its oxygen combines with a part of the phosphorous acid, which it converts into phosphoric acid; whilst the hydrogen dissolves a little of the phosphorus, and becomes disengaged in the form of phosphorated hydrogen gas, which is capable of taking flame in the air.

610. The fluid phosphorous acid precipitates the nitrate of silver of a white colour: this precipitate shortly after passes to a clear yellowish red; after which it grows deeper and deeper at such a rate that a few minutes are sufficient to render it almost black.

OF THE OXALIC ACID.

611. The oxalic is a vegetable acid, which is seen under the form of small white crystals, pointed, and lamellated; it is possessed of an acid taste extremely pungent: sometimes it is obtained in quadrilateral prisms, or in square cakes: it strongly reddens the infusion of tournesol.

612. When exposed in a phial to the action of caloric, it is rendered volatile, in the form of small crystals, which adhere to the superior part, and there is scarcely any residue of charcoal.

613. It dissolves very easily in water; its solution precipitates lime-water, and all the calcareous salts, not excepting

the sulphate: the precipitate consisting of oxalate of lime, dissolves readily in the nitric acid, whilst at the same time a great excess of the oxalic acid will not dissolve it.

614. The oxalic acid is capable of combining with the solutions of potash, soda, and ammonia, and forming at one time neutral oxalates soluble in water, at another super-oxalates (*acidulous oxalates*) which are less soluble; so that if one of these alkalies be taken, and the quantity of oxalic acid necessary for converting it into a neutral oxalate be poured upon it, the fluid will preserve its transparency; but if, in this state, more oxalic acid be added, instantly a number of small crystals will subside, formed of the acidulous oxalate of potash. It is unnecessary to observe that these crystals will be re-dissolved if the excess of acid be saturated with a fresh quantity of alkali.

OF THE TARTARIC ACID.

615. The tartaric acid crystallizes in fine needles, or in irregular hexaedral prisms, or square plates rather rhomboidal, with oblique edges: its taste is extremely acid and pungent; it reddens strongly the infusion of tournesol.

616. When exposed to the action of caloric in a small phial, far from becoming volatile like the oxalic acid, it becomes decomposed after the manner of vegetable substances; it grows black, smokes, swells up, and exhales a sharp vapour very pungent; it burns with a blue flame, and leaves behind a great quantity of spongy charcoal.

617. It dissolves very readily in water; its solution precipitates lime-water, but does not at all disturb the solution of sulphate of lime: the precipitate, consisting of tartrate of lime, dissolves readily in nitric acid, and in an excess of tartaric acid, a character which prevents its being confounded with the oxalic acid.

618. Combined with potash, soda, or ammonia, it acts in

the same manner as the last mentioned acid, and forms neutral tartrates which are soluble, or super-tartrates *(acidulous tartrates)* less soluble, according to the quantity of acid employed. (§ 614.)

ARTICLE XI.

SPECIES XI.—ALKALIES, CAUSTIC OR CARBONATED.

VAR. 1. Potash, Caustic or Carbonated.
2. Soda, Caustic or Carbonated.
3. Ammonia, Caustic or Carbonated.

OF POTASH.

619. Alcoholized potash, *(potasse à l'alcohol)* deprived of its carbonic acid (deut-oxyde of *potassium*) is solid, of a white colour; its taste is acrid, and excessively caustic: applied to the fingers, it renders them greasy, and, as it were soapy; it turns the syrup of violets green, with great energy; and restores the blue colour to the infusion of tournesol, when reddened by acids.

620. Exposed to the action of caloric, it fuses at a little above a red heat.

621. When brought in contact with the air, at the ordinary temperature, it instantly attracts the moisture and the carbonic acid, and goes into *deliquium.*

622. Potash dissolves readily in distilled water; the solution turns the syrup of violets green, and is not disturbed by the addition of carbonic acid gas, nor by water saturated with this gas; a character of the utmost importance, which serves to distinguish this alkali from barytes, strontian, and lime.

623. The solution of potash poured into the deuto-muriate of platina, gives rise to a canary-yellow precipitate, consisting

of the deut-oxyde of platina, potash, and muriatic acid. This precipitate is a little soluble in water, from which we ought to conclude that it cannot be obtained without employing a solution not much diluted.

624. Potash forms with the sulphuric, nitric, &c. acids; sulphates, nitrates, &c. which are soluble. When a concentrated solution of sulphate of potash, is added to the acid sulphate of simple alumine dissolved in a small quantity of water, the two solutions very soon begin to act upon each other, especially if agitated, and deposit a number of small white crystals, composed of sulphuric acid, potash, and alumine (alum). Soda, which has the greatest analogy to potash, will not produce this phenomenon.

625. When pure potash is poured into the nitrate of silver, there is formed a blackish brown precipitate of oxyde of silver, wholly soluble in pure nitric acid.

626. Sugared water, and a strong infusion of tea, experience no change from this alkali in solution.

627. Red wine passes into a very deep green on the addition of a few drops of the solution of potash; the fluid preserves its transparency.

628. The solutions of albumine and gelatine are not at all disturbed by this alkali; the same thing happens with milk and bile.

629. Fluid blood is not coagulated by potash: this alkali, on the contrary, prevents the spontaneous coagulation of this fluid.

OF THE *LAPIS INFERNALIS.*

630. The *lapis infernalis* differs only from pure potash, in that it contains sulphate and muriate of potash, silex, a little oxyde of iron, &c.: therefore when it is dissolved in water, and treated by a solution of nitrate of silver, beside the precipitate of oxyde of silver, soluble in pure nitric acid, there

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is obtained a muriate of silver, which is curdled, and insoluble in this re-agent. The soluble salts of barytes demonstrate also the presence of sulphate of potash, by producing a white precipitate of sulphate of barytes, insoluble in water and in pure nitric acid. In other respects the *lapis infernalis* possesses all the properties of the pure potash explained in § 619 *et seq.*

SUB-CARBONATE OF POTASH (*SALT OF TARTAR*).

631. The sub-carbonate of potash of commerce, always contains sulphate and muriate of potash, silex, and a small quantity of oxyde of iron, and of manganese; it does not crystallize, and is commonly found in the form of white masses slightly inclining to yellow, possessed of an acrid caustic taste. Its action upon the syrup of violets, upon water, and the deuto-muriate of platina, is the same as that of pure potash.

632. The sulphuric, nitric, and muriatic acids, likewise transform it into a sulphate, nitrate, or muriate, and set at liberty the carbonic acid gas, with a greater or less degree of effervescence. The sulphate thus obtained gives, with the acid sulphate of alumine, crystals of alum. (§ 624.)

633. The solution of sub-carbonate of potash, when poured upon the soluble muriates or nitrates of barytes, strontian, and lime, furnishes white precipitates, formed by carbonic acid, combined with one or other of these alkalies; (*Rationale*, vide page 23, note §): in like manner, by the addition of a strong acid, we may decompose this carbonated precipitate, by disengaging the carbonic acid gas with effervescence.

634. Sugared water, wine, tea, albumine, gelatine, milk, and bile, behave with the solution of this salt as with pure potash.

ACTION OF POTASH UPON THE ANIMAL ECONOMY.

635. The caustic effects of *the lapis infernalis*, when applied to the exterior of the body, are too well known to need any description in this place; we shall therefore confine ourselves to the results of the introduction of potash, and of the sub-carbonate of potash into the veins, and into the stomach.

Experiment 1st. Five grains of *lapis infernalis* dissolved in a drachm of distilled water, were injected into the jugular vein of a small dog six months old: the animal immediately experienced a slight trembling of the muscles of the trunk, and died at the end of two minutes, without giving the least sign of pain or convulsions. The body was immediately opened. The heart was of great bulk; the two ventricles were full of great clots of black blood; the lungs were crepitating, and did not appear to have been injured: the muscles were palpitating. The same experiment repeated upon a stronger dog, furnished similar results.

Experiment 2nd. Thirty-two grains of *lapis infernalis* in a solid form, were swallowed by a middle-sized dog. The animal appeared to be burnt during the deglutition of this caustic. At the end of five minutes he vomited some white matter mixed with yellow and green, after making the most violent efforts. This matter imparted a strong green colour to the syrup of violets, and produced a canary-yellow precipitate with the deuto-muriate of platina (§ 619 and 623). The vomitings were renewed three minutes after; the animal uttered plaintive cries, and was tormented with the most excruciating pains; his mouth was full of foam, his breathing difficult. About a quarter of an hour after the ingestion of the poison, he vomited three times, in the space of five minutes, some

bloody matter in small quantity, imparting likewise a green colour to the syrup of violets: he continued to suffer for two hours. The next day he was in a state of great dejection. On the third day he exercised his functions very languidly: he was almost dying, and expired in the night.

Dissection. The mucous membrane of the œsophagus was for the most part red; and presented here and there black portions. The stomach was empty; its internal coat was extremely red throughout its whole extent; there was in the vicinity of the pylorus a perforation about eight lines in diameter; it was surrounded by an elevated edge, which was livid, hard, and formed by a matter like blubber, and a small quantity of black coagulated blood. The mucous membrane of the duodenum and jejunum, likewise exhibited a very strong red colour. The lungs were sound.

Experiment 3rd. A dog of middle-size was made to swallow two drachms of the sub-carbonate of potash of commerce fasting; immediately afterwards the animal experienced horrible pain; he rolled upon the ground in a state of the greatest agitation. At the end of five minutes, he vomited, with great effort, some white matter, rather thick, which turned the syrup of violets green, and produced effervescence with the sulphuric acid (631 and 632). He constantly moaned plaintively, and breathed with difficulty. These symptoms went on increasing till the moment of death, which took place twenty-five minutes after the ingestion of the poison.

Dissection. The mucous membrane of the stomach was of a very deep red colour throughout its whole extent; many of the vessels running over it were injected; there was no sensible alteration in the intestines, nor in the lungs.

These experiments prove, that pure potash injected into the veins, produces death by coagulating the blood; when introduced into the stomach, it inflames this viscus, corrodes,

and perforates it, so that the animal dies of a true *gastritis*, which sometimes terminates in gangrene.*

SYMPTOMS OF POISONING BY THE CAUSTIC POTASH.

Plenck reports that a patient of a strong constitution, swallowed an ounce of salt of tartar (sub-carbonate of potash); he was shortly afterwards seized with a violent vomiting, which continued for forty-eight hours, and with an inflammation of the stomach, which however he did not sink under.

636. A styptic, urinous, and caustic taste; a severe heat in the throat; retchings, vomitings, sometimes of bloody matter, alkaline, turning the syrup of violets green, and most commonly effervescing with the acids; alvine evacuations copious, a most severe pain in the epigastrium, excruciating gripes, convulsions, injury of the intellectual faculties, &c.: these are the alarming symptoms produced by the alkali of which we have just been giving the history. If the potash has been swallowed in a tolerably strong dose, death soon supervenes.

LESIONS OF TEXTURE PRODUCED BY POTASH.

637. I am disposed to believe, from a great number of facts, that this alkali is, of all the corrosive poisons, that

* We have asserted (§ 629) that the blood was not coagulated by potash; what then can have caused the coagulation of this fluid, when it is injected into the veins? We are altogether ignorant of it. We shall only remark, how, under certain circumstances, the phenomena observed in animal fluids collected after death, are different to those which take place in the same fluids while still alive, and consequently, how much the physician ought to be upon his guard against the ill-timed applications of chemistry to physiology.

which the most frequently perforates the stomach; it produces also inflammation of the different coats of this viscus, and of the intestines.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY POTASH.

638. It is impossible to confound pure potash with any other substance, if we pay attention to the chemical characters we have laid down § 619 to 629.

If this alkali be found mixed with the fluid or solid contents of the stomach, whether found after death, or expelled by vomiting, its presence may without difficulty, be demonstrated by following the proceedings we are about to describe. 1st. After having filtered the liquid portion, it should be tried by the syrup of violets, which will be turned green if the fluid contain potash. 2nd. We must be assured that it does not exhale a smell of ammonia. 3rd. It should be precipitated by the deuto-muriate of platina, which will produce in it a canary-yellow sediment. 4th. It should be mixed with fluid carbonic acid, which will produce no disturbance in it; whilst it would precipitate lime, barytes, and strontian, if either of these alkalies should be found in the fluid. 5th. Lastly, it should be evaporated, in order to obtain the solid potash. (§ 619.) If we reflect ever so little on the property which potash possesses, of forming, with almost all animal substances, soluble compounds or mixtures, it will be seen, how very rarely it must happen that this alkali is not discovered by the methods we have just described.

TREATMENT OF POISONING BY POTASH.

639. Does there exist any antidote to potash?—From the

experiments which I have tried upon animals, it appears that vinegar diluted with water, is the medicine which can be administered with the greatest success. All the animals to whom caustic potash was administered, and who were immediately after plied with vinegar and water, suffered less than those who took water alone. If, after having introduced into the stomach of a dog a certain quantity of solution of caustic potash, he be made to swallow at the same moment a strong dose of concentrated vinegar, and the œsophagus be tied to prevent vomiting, the animal will make slight efforts to vomit, and exhibit but very few symptoms of poisoning. After death, which takes place at the end of four or five days, the texture is found uninjured, neither corroded or perforated, unless the quantity of vinegar given, should prove too weak to saturate all the alkaline particles.

The following fact serves to support what we here advance. M. Barruel, chemical preparator to the medical school of Paris, had the misfortune some years ago, to introduce into his mouth a solution of pure potash in alcohol, which he was pouring off by means of a small funnel; immediately after, he experienced a very violent heat and pain in the different points of the mucous membrane which lines the mouth; he had recourse to vinegar, which quickly saturated all this free alkali: by this means the symptoms, far from acquiring a fresh degree of intensity, diminished sensibly, so that the corrosive only produced a slight inflammation of the mucous membrane.

640. The physician called in to the assistance of persons poisoned by caustic or carbonated potash, should then have recourse to vinegar in large quantities, as this medicine is possessed of the two-fold properties of neutralizing the free alkali, and promoting vomiting. After the first moments of the accident, the patients should be quickly plied with cold or warm water, or with any other mucilaginous and emollient drink. As soon as the first symptoms are relieved, such

means should be employed, as are calculated to prevent or arrest inflammation of the organs contained in the abdomen, and in the superior parts of the digestive canal.

OF SODA.

641. The physical and chemical properties of this alkali, bear the greatest resemblance to those of potash; for which reason we shall limit its chemical history to a few characters, passing over those which are common to both these corrosives.

1st. Neither soda, nor sub-carbonate of soda, cause the least disturbance in the solution of deuto-muriate of platina, which depends upon the solubility of the triple salt formed by the muriatic acid, soda, and the deut-oxyde of platina. (§ 623.)

2nd. Soda, and carbonate of soda, combine with the sulphuric acid, and form a sulphate, with which crystals of alum cannot be obtained, on the addition of the acid sulphate of alumine. (§ 624.)

642. The mode of action of soda upon the animal economy, the symptoms and lesions of texture it produces, exactly resemble those we have described under the article *potash*. The same may be said of the mode of treatment necessary to oppose to the symptoms occasioned by this alkali.

OF FLUID AMMONIA (*ALCALI VOLATIL FLUOR*).

643. Fluid ammonia deprived of its carbonic acid is colourless: its taste is extremely caustic; its smell strong and pungent; it turns the syrup of violets green, and restores the blue colour to the infusion of tournesol, that has been reddened by acids.

644. Exposed to the action of caloric, it disengages a very great quantity of ammoniacal gas, which is colourless, extremely caustic, of a pungent smell which is intolerable, and is exceedingly soluble in water: the same phenomenon takes place at the ordinary temperature, although in a manner much less sensible.

645. Carbonic acid gas, and water saturated with this gas, do not at all disturb fluid ammonia.

646. The deuto-muriate of platina, is precipitated of a canary yellow by this alkali: the precipitate consists of muriatic acid, ammonia, and the deut-oxyde of platina; it is a little soluble in water.

647. The sulphuric acid saturates it, and forms sulphate of ammonia, which is capable of furnishing crystals of alum, on the addition of a concentrated solution of acid sulphate of alumine. (§ 624.)

648. Ammonia produces no turbidness in the solution of nitrate of silver. (§ 427.)

649. When an excess of this alkali is poured into a watery solution of sulphate of magnesia, a white precipitate of magnesia is obtained; the liquor which is composed of an *ammoniaco-magnesian* sulphate, after being filtered, precipitates a fresh quantity of magnesia on the addition of potash. This character suffices to distinguish with the utmost exactness, ammonia from potash and soda, which separate the whole of the magnesia, if mixed in sufficient quantity with the sulphate of this base.

650. Ammonia does not disturb sugared water; it changes the colour of red wine, and causes it to pass into green more or less deep.

651. Albumine, gelatine, milk, and bile, experience no sensible change from this alkali.

652. Fluid blood is not coagulated by fluid ammonia.

OF THE SUB-CARBONATE OF AMMONIA.

653. The sub-carbonate of ammonia is solid and white, its smell is ammoniacal, its taste caustic and pungent; it turns the syrup of violets green. When exposed to the air, it volatilizes by degrees. It is very easily soluble in cold water, and when this solution is boiled it evaporates, so volatile is it.

654. The sulphuric acid dissolves it with effervescence, and sets at liberty carbonic acid gas: the sulphate of ammonia obtained, furnishes crystals of alum when mixed with the acid sulphate of alumine.

655. The sub-carbonate of ammonia precipitates of a white colour, the soluble muriates and nitrates of lime, barytes, and strontian, which it converts into insoluble carbonates. Pure ammonia produces no precipitates with these salts.

656. Sugared water, wine, albumine, gelatine, milk, and bile, act with the solution of this salt as with pure ammonia.

ACTION OF AMMONIA UPON THE ANIMAL ECONOMY.

657. Fluid ammonia exerts a very strong action, when injected into the veins, or introduced into the stomach: it almost always occasions death; at one time by acting on the nervous system, and particularly the vertebral column; at another time by producing inflammation more or less considerable of the different parts of the digestive canal, the irritation of which produces lesion of the brain by sympathy.

Experiment 1st. Sixty grains of fluid ammonia tolerably concentrated, were injected into the jugular vein of a strong dog, although of small size. The animal instantly experienced a stiffness in his four limbs resembling tetanus: he had an involuntary excretion of urine, and his muscles, more particu-

larly those of the lips and extremities, were agitated by convulsive movements. He continued to live in this state till the tenth minute after the injection. The body was immediately opened: the contractile power of the muscles was already extinct, the lungs were crepitating, of a livid hue, and contained a small quantity of blood: there were found in the left auricle of the heart, a few gelatinous clots, formed by some blood of a deep red colour: the left ventricle contained a tolerable quantity of the same fluid not coagulated, and blackish.

Experiment 2nd. The œsophagus of a small dog was detached and perforated; thirty-six grains of concentrated fluid ammonia were then introduced into the stomach, by means of an elastic gum tube, and the œsophagus was tied below the opening, to prevent vomiting. The animal at first appeared to be burnt; at the expiration of five minutes, he became so insensible that he was thought to be dead; a few moments after, he was placed on his feet, and walked: he made excessively deep inspirations; had no inclination to vomit, neither were his limbs paralysed, or agitated with any convulsive movements; a slight trembling however was observed in his posterior extremities. Five hours after the introduction of the poison, he still preserved the power of walking, and continued to tremble. The next morning at seven o'clock (twenty hours after the poisoning) he was lying on the side in a state of insensibility, and dying. Three hours afterwards he expired.

Dissection. The œsophagus discovered no injury: the mucous membrane of the stomach was of a red colour, not very deep, throughout a part of its extent; in other parts it was white; there was neither ulceration, or any perforation of the coats of this viscus; the intestines and the lungs were in their natural state.

Experiment 3rd. A dog of the middle size was made to swallow at nine o'clock, two drachms and a half of sub-carbonate of ammonia reduced to a fine powder. Two minutes

afterwards the animal vomited a small quantity of yellowish matter, which was soft, and mixed with red blood. At six minutes after nine he was agitated with some convulsive movements: in a short time the convulsions became general and horrible; the muscles of the face and those of the trunk and extremities contracted with such violence that the animal was in a state of great agitation, and made frightful contortions. At the end of two or three minutes he became stiff, and stretched out his limbs: his body became curved, with the head forcibly bent backwards, which discovered the state of tetanus with which he was affected. He died at twelve minutes after nine.

Dissection. This was performed immediately after death. The heart no longer contracted; the left ventricle contained a great deal of fluid blood, of rather a dark red colour; the lungs were crepitating in many places; but some portions of them were found to contain very little air, and emitted no sound on being cut. The mucous membrane of the stomach was of a deep red colour, evidently inflamed on that half next the cardia; the other portion was white, and in its natural state.

The same experiment repeated with a similar dose of the sub-carbonate dissolved in three drachms of water, furnished results analogous to the foregoing. When this salt remains in the air free for a few days, it loses, in part, its poisonous qualities, which ought to be attributed to the evaporation of the ammonia which it contains in excess.

SYMPTOMS AND LESIONS OF TEXTURE PRODUCED BY FLUID AMMONIA.

658. Martinet, Huxham, Haller, &c. report cases wherein the fluid ammonia produced death in the space of a few minutes, after burning the lips, tongue, palate, &c., and

producing hæmorrhages of the intestines and the nose, and hectic fever.

If to these symptoms we join those we have mentioned in the preceding experiments (§ 657), a general idea may be formed of the symptoms produced by this energetic poison.

The lesions of texture produced by ammonia, are exactly similar to those observed after the ingestion of other corrosive substances.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY AMMONIA.

659. If the ammonia be pure, it will be sufficient to distinguish it by paying attention to its odour, and to the action exerted upon it by the syrup of violets, the carbonic acid, and caloric.

If it be combined with any fluid, its presence may be easily ascertained by distilling the mixture in a retort to which is adapted a recipient containing a small quantity of water: the free ammonia will quickly become volatile, and will saturate the fluid contained in the balloon: it is even of importance to paste on the interior of the receiver, a few pieces of paper of tournesol, reddened by an acid, in order that the smallest possible quantity of ammoniacal gas may be discovered by the restoration of the blue colour of the paper.

TREATMENT OF POISONING BY THE FLUID AMMONIA.

660. Vinegar and water ought to possess here the same advantages as those we have spoken of, in giving the history of potash; there is no doubt but that it is a medicine useful for neutralizing the ammonia, which may be found free in the

digestive canal. Unfortunately, this alkali exerts its action on the nervous system with extreme celerity, and the necessity of acting without the least delay cannot be too strongly enforced, in order to oppose the developement of the nervous symptoms, and of those which characterize the inflammations of the abdominal organs.

ARTICLE XII.

SPECIES XII.—CAUSTIC ALKALINE EARTHS.

VAR. 1. Barytes.
2. Lime.

OF BARYTES.

661. It is extremely useful to fix the attention of men of science on Barytes and its compounds. Being endowed with the most energetic poisonous properties, some of the preparations of this kind produce death in a very short space of time, amidst the most excruciating pains and violent convulsions; it is then of the utmost importance that those physicians who employ them in certain scrophulous and lymphatic affections, &c. should understand perfectly their effects, and the means of preventing the serious symptoms to which they give rise.

662. Barytes (deut-oxyde of *Baryum*) is a solid alkali of a greenish gray colour; its taste is acrid and caustic; it turns the syrup of violets green, and reddens turmeric.

663. Barytes, when perfectly calcined and solid, on being brought in contact with a few drops of water, absorbs them, renders them solid; disengaging at the same time a quantity of caloric, it increases its bulk, is divided, and reduced into a white powder. These phenomena depend upon the great

affinity which exists between these two bodies, and on the evaporation of a portion of the water in the midst of the barytes itself. When this alkali has been thus divided, it may be dissolved in distilled water, the temperature of which has been raised.

664. This solution, which is limpid, transparent, and colourless, turns the syrup of violets green, reddens the paper of turmeric, and restores the blue colour of the infusion of tournesol which has been reddened by an acid.

665. Carbonic acid gas, acido-carbonic water, and the alkaline sub-carbonates, produce in it instantly a white precipitate, composed of barytes and carbonic acid.

666. The sulphuric acid, and all the soluble sulphates, precipitate from it a sulphate of barytes, white, insoluble in water, and in the nitric acid. This precipitation takes place even when the solutions are extremely diluted.

667. Solid barytes dissolves in muriatic acid, and furnishes a salt which crystallizes in square plates, or in four-sided prisms, very broad, but not very thick. (§ 675.)

668. Wine is slightly disturbed by the water of barytes.

669. Sugared water experiences no change from this solution, at least if it do not contain any sulphates, or other salts, which this alkali will precipitate.

670. A strong infusion of tea is not precipitated by the water of barytes, and the mixture preserves the property of turning the syrup of violets green, even when it contains but a small quantity of alkali.

671. Albumine, gelatine, and milk, experience no sensible alteration from the solution of barytes.

672. Human bile is precipitated immediately of a greenish yellow colour.

OF THE CARBONATE OF BARYTES.

673. Carbonate of barytes differs from caustic barytes. 1st,

by its insolubility in water; 2nd, by the effervescence it produces when dissolving in the nitric or muriatic acids.

674. Carbonate of barytes, when calcined in a crucible with charcoal, gives out carbonic-oxyde gas, and barytes soluble in water.

OF THE MURIATE OF BARYTES.

675. This salt crystallizes in square plates, or four-sided prisms, very broad, and of little thickness; it has an acrid and very pungent taste; it reddens the tincture of tournesol, and does not change the colour of the syrup of violets.

676. Twice and a half its weight of distilled water, is sufficient to dissolve it at the ordinary temperature.

677. The solution, which is limpid, colourless, and transparent, experiences no change from the addition of ammonia, the affinity of which, for the muriatic acid, is weaker than that which combines this acid with barytes.

678. The sub-carbonates of potash, soda, and ammonia, decompose the muriate of barytes, by virtue of the law of double decomposition, explained page 23, Note §; there will be formed a white sediment of carbonate of barytes, which may be washed, dried on a filter, and calcined with charcoal, in order to extract from it pure barytes (§ 674).

679. Sulphuric acid, and the soluble sulphates, act with this salt as with the water of barytes; they precipitate from it a sulphate of barytes insoluble in water, or in nitric acid.

680. Nitrate of silver brought in contact with muriate of barytes furnishes instantly a copious precipitate of muriate of silver, while at the same time the fluid will contain nitrate of barytes. (See page 23, Note §.)

681. The hydro-sulphurets of potash, soda, and ammonia, prepared with distilled water, do not at all disturb the solution of muriate of barytes. If these re-agents contain a small quantity of sulphate of potash, of soda, or some metallic salts,

they produce, at the end of a certain time, a precipitate more or less copious. It is by so much the more important to pay attention to this character, since all the other metallic poisons which we have hitherto considered, yield an abundant precipitate either black, yellow, or red, on the addition of one or other of the hydro-sulphurets mentioned.

682. Muriate of barytes dissolved in water, and poured into Burgundy wine, slightly disturbs it, which depends upon the decomposition of the soluble sulphates which the wine contains. The precipitate consists of sulphate of barytes, and its quantity is in proportion to the quantity of sulphates contained in the wine.

683. Sugared water and a strong infusion of tea, undergo no alteration from the muriate of barytes.

684. Albumine, gelatine, and milk, are not precipitated by this salt. If a mixture be made of a small quantity of muriate of barytes, and a great quantity of milk, and this be brought in contact with sulphate of potash, a copious precipitate will instantly be obtained of sulphate of barytes, which proves that the greatest part of the muriate was only mixed with the milk.

685. Human bile is precipitated of a greenish yellow by the solution of this salt.

ACTION OF THE DIFFERENT COMPOUNDS OF BARYTES UPON THE ANIMAL ECONOMY.

686. *Muriate of Barytes.* Amongst the mineral poisons, there are very few which exert so powerful an action as the muriate of barytes; whether injected into the veins, introduced into the stomach, or externally applied, it produces death in a space of time exceedingly short.

Experiment 1st. I injected into the jugular vein of a robust dog, five grains of muriate of barytes, dissolved in a drachm of

distilled water; the animal instantly experienced a great degree of agitation: he beat himself violently, rolling himself upon the ground, and was attacked with convulsive movements in the limbs. At the end of three minutes he became calm, his breathing was not in the least impeded; he only shewed a general convulsive trembling. In this state he died six minutes after the injection—the dissection was immediately performed. The flesh was palpitating; the ventricles of the heart were swelled by a great quantity of large gelatinous clots, formed of blood of rather a deep red colour; a few of these clots were also found in the two auricles; neither the arterial or venous blood of the lower extremities were coagulated. The lungs were of a beautiful rose colour; they were crepitating, and contained a great deal of air: their texture in some few points, presented a greater degree of density than in their natural state—the stomach was sound.

Experiment 2nd. At twelve minutes after noon, the œsophagus of a strong, but small dog, was detached and perforated: one drachm thirty-six grains, of muriate of barytes, dissolved in six drachms of distilled water, were introduced into his stomach, and the œsophagus tied below the opening to prevent vomiting; at the expiration of ten minutes, the animal made violent efforts to vomit, and passed two liquid stools. At forty minutes after twelve, he began to be agitated with convulsive movements: he lay down upon his belly, and experienced such violent succussions, that he was lifted up and thrown over in spite of himself, making brisk leaps, like a frog submitted to the action of a strong galvanic pile. These phenomena ceased for a few seconds, in order to return again with a greater degree of violence. Five minutes after, the convulsive movements were very strong in the muscles of the face: it was not possible for the animal to keep himself on his feet; he fell as soon as he was lifted up. At fifty-five minutes after twelve, the pulsation of the heart was greatly accelerated; a hundred and thirty strokes might be counted in the minute.

The convulsive movements were confined to the right fore leg. He died at one o'clock.

He was instantly opened. The heart at the first moments was beating strongly, but the pulsations were sensibly diminishing, so that in the space of three minutes they were extremely rare and feeble. The left ventricle contained black fluid blood. The lungs were of their natural colour: their substance, which was preternaturally dense, contained scarcely any air, and was not crepitating.* The mucous membrane of the stomach was of a livid red colour almost throughout its whole extent: it could be easily removed by rubbing it lightly with a knife. The muscular coat exhibited two broad patches, each the size of a crown piece, of a cherry red colour. The stomach contained a certain quantity of food.

Experiment 3d. M. Brodie gave to a large cat, an ounce and a half of a concentrated solution of muriate of barytes: at the end of a few minutes the animal vomited; he experienced vertigoes, became insensible, and lay down; its pupils were dilated: it was motionless, and had convulsions from time to time. At the expiration of sixty-five minutes it appeared to be dead: but on applying the hand between its ribs, it was perceived that the heart still beat a hundred strokes in a minute. A tube was introduced into the trachea, and the lungs were inflated about thirty-six times in a minute. The pulse, however, ceased to beat, and in seven minutes more, the circulation was entirely suspended.†

* It frequently happens, when animals that have been poisoned, die in terrible convulsions; that the lungs contain scarcely any air, and that their substance becomes hardened. It may indeed be easily conceived, that in this state of convulsion, respiration would be effected with great difficulty, and that *asphyxia* ought to ensue. It is particularly necessary to pay attention to this circumstance before we conclude that the morbid condition of the lungs really depends upon the direct action of the poisonous substance.

† Philosophical Transactions, 1812; Further Experiments, &c. &c. by M. Brodie.

Experiment 4th. At one o'clock in the day, a wound made in the back of a small dog, was sprinkled over with forty-eight grains of solid muriate of barytes, and twenty-four grains more of the same salt dissolved in a drachm of distilled water, were added; the flaps of the wound were united by three sutures. At the expiration of two minutes, the animal began to run about the room; he endeavoured to make his escape; his motions were very nimble, and he could not remain at rest a moment: this state of things continued for ten minutes. A quarter of an hour after the operation he had a stool, and twice vomited a small quantity of bilious matter. At the end of six minutes more he made some fruitless efforts to vomit. At twenty-five minutes after one he experienced some very strong convulsive shocks; he was lying down on the belly, and twitched sometimes the fore, sometimes the hind legs; the muscles of the back of the head, those of the face, and of the trunk, participated in this general state of convulsion. The animal made horrible contortions, and was not able to stand on his legs; he was insensible; his breathing was not impeded; he had a great deal of foam at the mouth, and uttered no plaintive cry. This state of things continued till four o'clock; from that time he became as it were motionless, and expired twenty-five minutes after. The body was immediately opened. The blood contained in the left ventricle of the heart was fluid, and of a red colour, tolerably bright. The pulsations of the heart were strong and frequent; the lungs were of a beautiful rose-colour and crepitating; their texture appeared a little more dense than in the natural state. The mucous membrane of the stomach and intestines presented no alteration.

Experiment 5th. M. Brodie sprinkled with ten grains of muriate of Barytes, finely powdered, and moistened with two drops of water, two wounds made on the side and on the thigh of a rabbit. At the expiration of four minutes the animal began to experience the action of the poison; it had vertigoes:

the posterior extremities became paralysed, and it fell, by a little at a time, into a state of general insensibility; the pupils were dilated—the animal lay down motionless. It was agitated from time to time by convulsive movements; the pulse beat a hundred and fifty times in a minute; the pulsations were feeble, and accompanied with some intermissions. Twenty minutes after the application of the poison, the animal appeared to be dead; but on opening the chest, the heart was seen still to beat, and its movements did not cease till about three minutes after death.*

We may conclude from all these facts. 1st. That muriate of barytes, when injected into the veins, produces death by acting upon the nervous system, and coagulating the blood: 2nd. That when applied externally, or introduced into the stomach, its exerts its action likewise upon that system, after having been absorbed and carried into the current of the circulation; it produces also in these circumstances, inflammation of the texture with which it comes in contact. Mr. Brodie is of opinion from the two experiments he instituted, that the muriate of barytes occasions death by acting upon the brain and the heart.

OF BARYTES AND CARBONATE OF BARYTES.

Experiment 1st. At five minutes after one o'clock, a small dog was made to swallow thirty-three grains of caustic barytes, reduced to a fine powder. At the end of ten minutes the animal was lying down upon his belly, and appeared to suffer considerably. At three quarters after one, he vomited, with much effort, a small quantity of mucous matter, of a greenish colour, mixed with blood; he had the hiccup, and uttered cries excessively plaintive. At two o'clock, he was in such a state of insensibility, that he might have been taken for dead; he

* Philosophical Transactions, *Vol. cit.*

might be pinched without giving the least sign of pain; his limbs, when lifted up and abandoned to their own weight, fell like an inert mass of matter; the pupils were dilated. At twenty-five minutes after two, he vomited a small quantity of greenish yellow matter, after making violent efforts: his inspirations were exceedingly deep; he still continued to moan. He died at four o'clock, after having experienced some slight convulsive movements in the posterior extremities.

Dissection. The mucous membrane of the stomach was of a deep red colour throughout its whole extent: it exhibited in that portion next the pylorus, two black spots, formed by venous blood extravasated upon the muscular membrane. The duodenum, and the other intestines were in their natural state. The lungs were of a deep red colour towards the posterior lobe; their substance was crepitating.

Experiment 2d. The œsophagus of a dog of middle size, was detached and perforated; a drachm of barytes perfectly pulverized and inclosed in a small paper cone, was then introduced into the stomach; the œsophagus was then tied below the opening to prevent vomiting. The animal died at the expiration of an hour, after having suffered excruciating pains, convulsive movements, and the general insensibility described in the preceding experiment.

Dissection. The stomach contained the paper cone, in which there was still a great deal of barytes; the mucous membrane was of a black red colour throughout its whole extent: the intestines and lungs presented no sensible injury.

Experiment 3d. At eleven o'clock, a small dog was made to swallow a drachm of powdered carbonate of barytes; at half-past one, the animal vomited a small quantity of liquid matter, in which a portion of the powder swallowed could be easily perceived. He began to moan, fell into a state of great dejection, and died at five o'clock. The mucous membrane of the stomach presented the same alteration as described in the two preceding experiments.

Barytes then, whether pure or carbonated, when introduced into the stomach, produces death, by acting upon the nervous system; it corrodes at the same time the viscus with which it comes in contact.

SYMPTOMS OF POISONING BY BARYTES.

687. We are not acquainted with any detailed case of poisoning by the compounds of barytes; for which reason we are obliged to refer, for the history of the symptoms and lesions of texture produced by this alkali, to what we have laid down in the preceding paragraphs.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY BARYTES, AND ITS COMPOUNDS.

688. *Muriate of Barytes.* A salt which does not redden the tincture of tournesol, which does not turn the syrup of violets green, which is not precipitated by the hydro-sulphurets nor by ammonia, but which on the contrary is precipitated by sub-carbonate of ammonia, soda, or potash; which is not soluble in concentrated alcohol; which furnishes, with sulphate of potash or sulphuric acid, a white precipitate insoluble in water, and in nitric acid, and which gives with nitrate of silver a curdled precipitate of muriate of silver likewise insoluble in nitric acid, can be no other than the muriate of barytes. The practitioner will easily recognise this salt, when it is without mixture, by submitting it to the tests we have just mentioned.

689. If muriate of barytes has been mixed with fluids capable of hindering the menstrua from acting upon it, as they would have done if it had been alone, it will be necessary to treat the suspected fluids with sub-carbonate of ammonia dissolved in water; in a short time a precipitate of carbonate of ba-

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rytes will be obtained, which must be dried on a filter, in order to be calcined afterwards with charcoal; by this means the caustic barytes will be obtained, the properties of which are extremely remarkable and easy to determine (§ 663). We must proceed in the same manner when we seek for the salt in the fluids vomited, or in those which may be contained in the stomach after the death of the patient.

690. Lastly, when all the attempts made on the fluid matter have been insufficient to discover this poisonous substance, it will be necessary to calcine in a crucible, all the solid parts, previously dried and mixed with charcoal finely powdered. If at the end of two hours of a strong heat, *sulphate of barytes* be obtained, which is easy to recognise by the characters we have described (§ 520), we may be assured that the poison has been produced by a soluble preparation of this kind, which has probably been rendered insoluble by its union with some sulphates.* If, instead of a sulphuret of barytes, the calcined product should contain *caustic barytes*, (§ 663) there would be strong grounds for believing that the muriate has been converted into a carbonate by its mixture with some sub-carbonates combined with the food.

691. *Barytes.* What we have just advanced, will render it needless to enter into the details of the experiments which the practitioner ought to institute in order to discover this alkali, the chemical properties of which we have explained in the beginning of this article.

* This case may happen, 1st, when a person recently poisoned by the muriate of barytes, has been made to swallow sulphate of potash or of soda, and a part of this salt has been converted into sulphate of barytes insoluble and excreted with the matter of the vomiting, or of the stools; 2nd, when the food and drinks found in the stomach contain soluble sulphates in sufficient quantity; 3rd, lastly, when death has not taken place until after the ingestion of some sulphates, or of food charged with these kind of salts, and the solid contents of the stomach are submitted to examination. This case is extremely uncommon, if the patients are quickly plied with sulphates; for then the poison is found to be decomposed altogether, and exerts but very little action.

TREATMENT OF POISONING BY BARYTES AND ITS COMPOUNDS.

692. Does there exist any antidote to barytes, and the muriate of barytes?

Reflecting on the force with which barytes and the salts of barytes, lay hold on the sulphuric acid, in order to form insoluble sulphate of barytes, I have thought that the sulphates would be (of the salts the most easy to procure) those which would oppose with the most energy the murderous action of poisons of this kind. I shall give the results of my experiments.

1st. A small dog was made to swallow four drachms of sulphate of barytes reduced to a fine powder: at the end of three hours the animal vomited a small quantity of whitish matter; the next day he was perfectly recovered. Six drachms of the same sort were given to another small dog: he did not appear at all incommoded, and made no effort to vomit.

2nd. At 11 o'clock, the œsophagus of a little dog was detached and perforated; two drachms of muriate of barytes dissolved in an ounce of distilled water, were introduced into the stomach; six minutes afterward an ounce and two drachms of sulphate of soda (Glauber salts) dissolved in four ounces of water, were likewise introduced into that viscus; the œsophagus was then tied below the opening to prevent vomiting. A quarter of an hour had scarcely elapsed when the animal made violent efforts to vomit. At forty minutes after eleven, he had a very copious liquid stool; the matter of which was white, milky, and turbid, as if it had contained a small quantity of *sulphate of barytes* in suspension. At twelve o'clock, he had a second stool of the same nature, in which small white earthy lumps could be distinguished, which on analysis yielded sulphate of barytes: at ten o'clock he again evacuated a fresh quantity of this whitish, grumous liquid, and made fresh efforts

to vomit. At six in the evening he had no convulsive movements, or paralysis of the limbs; he was walking about, and endeavoured to make his escape.—Next morning at six o'clock he exhibited no remarkable symptom: he appeared fatigued and dejected. He died at ten o'clock in the evening, thirty-five hours after the ingestion of the poisonous substance.

Dissection. The lungs were sound; the mucous membrane of the stomach and intestines was almost in its natural state; there was observed only in the portion next the pylorus, a small dark spot of the size of a pea, which appeared to be inflamed. Let the results of this experiment be compared with those which we have spoken of, § 686, *experiment* 2nd.—The animal who was the subject of it, had taken only one drachm thirty-six grains of this salt; he lived only forty-eight minutes; was agitated by horrible convulsive movements, and after death, the mucous membrane of his stomach was found inflamed throughout its whole extent. It appears then certain, that the *soluble sulphates* are antidotes to the muriate of barytes, provided they are administered before this salt has been absorbed in sufficient quantity to act in a fatal manner upon the nervous system.

693. The physician called in to the assistance of the unfortunate persons who may have swallowed compounds of this kind, ought then to have immediate recourse to copious solutions of sulphate of soda, or sulphate of magnesia (Glauber or Epsom salts), or even to the water of pits, which is often found to contain a sufficient quantity of sulphate of lime. If the vomiting does not take place in a short space of time, it should be encouraged by tickling the uvula with a feather, by irritating the throat, and even by the administration of an emetic. By these means the poison will be expelled very frequently, before it has been absorbed in a quantity sufficient to produce death. The after-treatment of this poisoning will vary according to the degree of violence, and the nature of the symptoms to which the patient shall be subjected.

OF QUICK LIME.

694. Lime (oxyde of calcium) is solid, of a grayish white colour, and caustic taste; it turns the syrup of violets green, with some energy, and reddens the colour of turmeric. Its specific gravity is as 2, 3.

695. When it has been perfectly calcined, it produces with water the same phenomenon as barytes (663), and furnishes a limpid solution.

696. Lime-water turns the syrup of violets green, reddens turmeric, and restores the blue colour to the infusion of tournesol which has been reddened by an acid.

697. Carbonic acid gas, acido-carbonic water, and the soluble alkaline sub-carbonates, produce in it immediately a copious white precipitate, composed of lime and carbonic acid. This carbonate of lime is easily dissolved by an excess of carbonic acid; all the acids decompose it, producing an effervescence more or less violent, in consequence of the carbonic acid which enters into its composition.

698. The sulphuric acid does not precipitate lime-water, while the smallest quantity of an exceedingly diluted solution of barytes, becomes instantly turbid on the addition of that acid. These phenomena may be easily comprehended, by reflecting that the sulphate of lime only requires about 300 parts of water to dissolve it, whilst the sulphate of barytes is insoluble in several thousand times its bulk of this fluid.

699. The oxalic acid, and oxalate of ammonia precipitate lime-water of a white colour, and the oxalate thus formed does not dissolve in an excess of oxalic acid.

700. Burgundy wine brought in contact with lime-water, changes its colour, passes to a clear yellow, and yields a flaky precipitate of a brown colour, bordering a little on violet.

701. When a small quantity of lime-water is added to a strong infusion of tea, a deposition is perceived of a greenish

colour, rather deep. If the quantity of lime-water be increased, a precipitate not very abundant takes place, of a red ochre colour.

702. Albumine, gelatine, and milk, produce no change in lime-water. This alkali, when mixed with these bodies, possesses the property of turning the syrup of violets green.

703. Human bile is slightly disturbed by lime-water, and a brown precipitate is observed to be deposited in the space of a few hours.

ACTION OF QUICK LIME UPON THE ANIMAL ECONOMY.

Experiment. A small dog was made to swallow a drachm and half of quick lime reduced to powder. At the end of ten minutes, the animal vomited a tolerable quantity of alimentary matter; his mouth was filled with foam, and he appeared to suffer a little pain. The next day (2nd day) he appeared to be recovered, and ate with an appetite. The two following days (3d and 4th) he continued in good health. On the 5th day, he was made to swallow three more drachms of quick lime powdered. He vomited two minutes after, and fell into a state of dejection: he made complaints from time to time, and died three days afterwards, without having experienced either vertigoes, convulsive movements, or paralysis.

Dissection. The mouth, fauces, and œsophagus, were a little inflamed: the mucous membrane of the stomach exhibited, throughout its whole extent, a deepish red colour: it was evidently inflamed: the coats beneath it did not appear any way affected: the pylorus, duodenum, and the other parts of the digestive canal were in their natural state. The lungs, which were of a rose colour, contained air, and exhibited no trace of turgidness, or thickening.

We must conclude from this experiment; 1st, That lime introduced into the stomach, is not a very energetic poison:

2nd, That it occasions death by producing inflammation of the texture with which it comes in contact.

SYMPTOMS AND LESIONS OF TEXTURE PRODUCED BY QUICK LIME.

704. Nausea, vomitings, epigastralgia, colics, frequent stools, and all the symptoms which characterize, or are complicated with, inflammation of the stomach and intestines, may be the consequence of the imprudent taking this caustic alkali.

705. When the texture is examined after death occasioned by lime, nothing is observed but an inflammation more or less intense of those parts which have been in contact with it. (Vide preceding experiment.)

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY LIME.

706. Lime, when free from mixture, is soluble in water; its solution turns the syrup of violets green: it produces a white precipitate, with the carbonic and oxalic acids; lastly, it experiences no change from sulphuric acid. These characters are sufficient to decide upon its presence. (§ 694 et seq.)

707. When this alkali forms part of the matter vomited, or that found in the stomach after death, the mixture must be calcined, if the tests are not capable of detecting it: by this means, all the animal and vegetable parts capable of concealing it, will be destroyed, and this alkali will soon be obtained in a caustic state. The residuum must then be treated by distilled water, and examined by all the re-agents we have spoken of, in giving its chemical history.

TREATMENT OF POISONING BY LIME.

708. All the rules established in § 639, where we have marked out the steps the physician ought to follow in order to cure persons poisoned by caustic potash and soda, may be applied here.

ARTICLE XIII.

SPECIES XIII.—PHOSPHORUS.

709. Many respectable physicians have administered this substance with the intention of combating certain chronic diseases, adynamic and ataxic fevers, epilepsy and paralysis; some among them are of opinion that this medicine is possessed of properties which promise to render it extremely useful: other practitioners, who have been witness to the ill effects it has produced in certain nervous affections, have not concealed the danger attendant upon its administration, even when the greatest precautions are used. Zealous for seeing the Materia Medica founded upon sure principles, these praise-worthy men have published cases in which they have seen phosphorus produce death in a very short time, and accompanied with the most excruciating pains.

We are of opinion that it would be useful to direct the attention of scientific men to a substance, the properties of which are capable of becoming frequently fatal to the animal economy.

PHYSICAL AND CHEMICAL PROPERTIES OF PHOSPHORUS.

710. Phosphorus is a solid body, semi-transparent, slightly brilliant, flexible, and soft: it is easily cut with a knife, and

it exhibits a vitreous fracture, sometimes a little lamellated: it has a very sensible smell of garlic, and similar to that of arsenious acid, when thrown on burning charcoal; it appears insipid when pure; it is commonly transparent and colourless; its specific gravity is as 1,770.

711. If phosphorus is put in the bottom of a phial containing water, and the temperature be raised to the 43d degree of the centigrade thermometer, it goes into fusion, and becomes transparent, like a white oil; if left to cool very slowly, it preserves its transparency, and remains colourless.

If instead of heating it in water, it be made to melt in contact with the air, it inflames, disengages a great quantity of caloric and of light, and gives rise to the solid phosphoric acid, which appears under the form of white vapours, very thick, and to phosphorated azotic gas. A red residuum is also obtained, formed, according to the recent experiments of M. Vogel, of oxyde of phosphorus.

Rationale. The oxygen gas acts upon the phosphorus, and from the gaseous state in which it was, becomes solid, disengaging at the same time a great part of the caloric it contains, and acidifies the combustible body; at the same time the azote dissolves a small quantity of phosphorus.

712. This combustible body, brought in contact with the air at the ordinary temperature, is quickly surrounded by a white vapour or smoke, remarkable for the greenish light which it presents in the dark; it grows yellow, passes immediately into red, and ends by disappearing, transforming itself into phosphorous acid and phosphorated azotic gas.

Rationale. The azote of the air, by reason of the chemical action it exerts upon phosphorus, separates its molecules, destroys its force of cohesion, and dissolves some of its particles; then the oxygen slowly lays hold of the molecules of phosphorus in a state of extreme division, oxydates them, and causes them to pass into the state of phosphorous acid, capable of becoming liquid on combining with the water of

the atmosphere. It is evident that there ought to be in this slow combustion only a very feeble disengagement of caloric and light.

713. Phosphorus is insoluble in water, and does not possess the property of decomposing this fluid at the ordinary temperature of the atmosphere: nevertheless, if the water in which it is preserved be aerated, it changes its nature; from being transparent it becomes opaque, and covers itself over with a white coat, which in a short time becomes red, especially by the contact of rays of light. The water acquires a remarkable smell and acidity, owing to the phosphorous acid which is formed. It is easily seen that all these phenomena are the result of the fixation of the oxygen of the air contained in common water.

714. Nitric acid of commerce, being dropped upon phosphorus, converts it into phosphoric acid, by yielding to it a portion of the oxygen it contains, and disengaging a great quantity of heat, and of nitrous gas, which the oxygen of the atmosphere changes into orange-yellow nitrous acid gas.

715. Oils dissolve phosphorus, provided the temperature be elevated ever so little. The solution made by oil of olives, becomes very turbid on cooling, and acquires a yellowish colour.

716. Alcohol and æther are likewise capable of dissolving this combustible body.

717. Sugared water, a strong infusion of tea, the infusion of galls in alcohol, albumine, gelatine, milk, bile, &c. do not dissolve phosphorus at the ordinary temperature. This combustible body, when mixed with these substances, undergoes no other change than what occurs to it in aerated water.

ACTION OF PHOSPHORUS UPON THE ANIMAL ECONOMY.

718. Phosphorus, dissolved in oil of olives, and injected

into the veins, produces death in a very short space of time: when introduced into the stomach, it occasions symptoms, which are exceedingly variable according to the state of division in which it has been administered, but which in all cases produce death. What is the mode of action of this poisonous substance?

Experiment 1st. M. Magendie, in a very excellent Memoir on pulmonary transpiration, has made it appear, that when phosphorated oil is injected into the pleura of a dog, in the course of a few minutes the animal exhales at each expiration, a white vapour, tolerably copious, in which there exists a very great quantity of phosphorous acid. The phenomenon is much more perceptible when this preparation is injected into the jugular vein: before the injection is completed, the animal gives out from the nostrils copious streams of phosphorous acid, and quickly expires.*

Experiment 2nd. I injected a drachm of phosphorated oil into the jugular vein of a very strong dog; the animal instantly exhaled by the mouth and nostrils copious vapours of phosphorous acid; his respiration became panting, and extremely difficult; and in this situation he died in about twenty minutes, after having thrown up a very considerable quantity of a bloody serosity. Death was not preceded by any remarkable nervous symptom. He was opened immediately after; the blood contained in the left ventricle of the heart was fluid, and as black as that which filled the right ventricle. The lungs exhibited several livid patches, of a close texture, and less crepitating than in the natural state; throughout all the rest of their extent they were of a rose colour. The stomach presented no alteration.

It is incontestable from these experiments, that phosphorus, divided by oil, and introduced into the current of the circula-

* Experience pour servir à l'Histoire de la Transpiration Pulmonaire; Mémoire lu à l'Institut de France, en 1811, p. 19.

tion, passes through the lungs, absorbs the oxygen of the air, and passes into the state of phosphorous acid: probably there is formed likewise a small portion of phosphoric acid. The passage of these acids through the delicate vessels of the pulmonary organ, produces an almost instantaneous inflammation of their substance; an inflammation which, supposing the lungs continue their action, soon gives way to asphyxia and death.

Experiment 3rd. The œsophagus of a small dog was detached and perforated; fourteen small cylinders of phosphorus, the weight of which was a hundred and forty grains, were then introduced into the stomach, and the œsophagus was tied below the opening to prevent vomiting. The animal had eaten nothing for thirty hours; he did not experience any inclination to vomit; he uttered no plaintive cry, and fell by degrees into a state of dejection very considerable; he died twenty-one hours after the operation.

Dissection. The mucous membrane of the stomach was strongly inflamed, and covered with a stringy and flaky matter, which could be detached with the greatest ease: the muscular coat was of a bright red through a part of its extent. The stomach contained a small quantity of a thick greenish fluid; the mucous membrane lining the duodenum, the jejunum, and the first half of the ileon, was of a purple red colour, and covered by a very thick fluid, as black as ink. No phosphorus was perceived in any of the parts of the digestive canal, we have been speaking of. The lower half of the ileon exhibited ten nodes at variable distances from each other; these nodes were formed by ten cylinders of phosphorus of a reddish colour, the weight of which was 94 grains, which were covered with moisture, and diffused a smoke tolerably copious on opening the intestine that contained them. The mucous membrane corresponding to the places where they were found, were much less red than those parts they had already passed through. Three other of these nodes were observed towards

the inferior portion of the colon, which were formed by three small cylinders of phosphorus, weighing twenty six grains, and the mucous membrane of this intestine was still less red than that which lined the extremity of the ileon. In the interior of the rectum was seen the fourteenth cylinder of phosphorus, enclosed in a small quantity of excrementitious matter, and weighing only seven grains; the internal coats of this intestine were in their natural state. It appears then that only a hundred and twenty-seven grains of phosphorus were found after the death of the animal.

Experiment 4th. A dog of middle size was made to swallow a drachm of phosphorus cut into eight small pieces, the animal had eaten very heartily two hours before. At the expiration of four hours he had experienced nothing remarkable? he had not felt the least inclination to vomit. The next day he refused food, and was somewhat dejected. He died on the third day without having been affected with any convulsive movements.

Dissection. The mucous membrane of the stomach was of a purple red throughout its whole extent; that which lined the duodenum and jejunum, was likewise exceedingly red; there were no remarkable alterations in the other intestines. In the colon and rectum the small cylinders of phosphorus were found, coloured red, and of a less bulk than when taken.

Experiment 5th. At half past eleven o'clock, there were introduced into the stomach of a small, but strong dog; twenty-four grains of phosphorus, dissolved in three drachms of olive oil. At the expiration of one minute he exhaled through the mouth and nostrils, a copious vapour, having the smell of phosphorous acid: he uttered cries excessively plaintive, and appeared to be suffering the most violent pains; he lay down upon one side, where he remained as if immoveable, without shewing the least sign of convulsion. Three quarters of an hour after the introduction of the poisonous substance, he

vomited some yellowish matter, smoking, and having a smell of garlic: he continued to moan, and died at four o'clock. Six minutes before he expired, he beat himself with all his strength; all his muscles were agitated with convulsive movements, and he made horrible contortions.

Dissection. The stomach was empty, and perforated with three holes in that half corresponding to the cardia: two of these openings were as broad as a shilling; the other, which was circular and larger, measured about ten lines in diameter. The mucous membrane of those parts of the stomach which had not been perforated, was reduced to a stringy kind of pulp; the muscular coat presented large ulcerations. The lungs were red, distended with blood, and not at all crepitating.

It results from the three last experiments, 1st, that phosphorus introduced into the stomach, occasions death, by producing inflammation, more or less violent, in different parts of the digestive canal, which, if violent, sympathetically induces a lesion of the nervous system. 2nd. That it gives rise to these symptoms by combining with the oxygen of the air contained in the alimentary canal, and that it gives birth to phosphorous acid, and probably to phosphoric acid, in such manner that the corrosion depends upon the action of these acids. 3d. That whenever the phosphorus is introduced in cylinders, phosphorous acid is constantly formed, which corrodes the portions of the membranes with which it comes in contact: so as the phosphorus proceeds progressively from the stomach to the rectum, it may be understood, that the inflammation ought to be strongest in those places where the greatest possible quantity of phosphorous acid is formed; for instance, those which the combustible has already passed through. (Exper. 3d.)

4th. That the combustion is slower in proportion as the stomach contains a greater quantity of food, the combustible body finding itself in that case enveloped, and consequently

more sheltered from the contact of the air. (Exper. 4th.)* 5th. That death soon succeeds when the phosphorus has been previously divided in oil: in this case the combustion is most rapid, and the animal dies amidst the most horrible convulsions. It is probable the product of this combustion is phosphoric acid.

M. Giulio, professor of medicine at Turin, in a physiological work on phosphorus, has drawn the following conclusions: 1st. That phosphorus introduced into the stomach and intestines of animals, undergoes there a combustion, and produces symptoms peculiar to that combustion. 2nd. That the burning irritation caused by the disengagement of caloric during this combustion, as well as the caustic impression of the sulphureous vapours, produces an inflammation in the œsophagus and intestines, proportioned to the quantity of phosphorus swallowed, dissolved and burnt. 3rd. That the inflammation of these parts, which is sufficient to account for the death of the animal, is not necessary to produce it. The *culinary* (*cuisante*) impression produced upon the nerves of the stomach and intestines, is sufficient to explain the murderous effects of phosphorus: thence arise the tremblings of the body; prostrations of strength, and the terrible convulsions, which in these experiments are constantly witnessed in animals submitted to the action of phosphorus internally administered in a sufficient dose.† 4th. That the death of frogs produced by the simple phosphorous vapours, and by the contact only of the interior parts of the mouth with phosphorus; that the speedy

* It even happens frequently, that the phosphorus has not yet acted upon the texture of the stomach, several hours after its ingestion. I gave to an animal a very great quantity of food; immediately after, I made him take two drachms of phosphorus cut into twenty small cylinders: at the expiration of eight hours he had not experienced any inconvenience. I opened him, and found the phosphorus enveloped in the food; the texture of the stomach did not exhibit the smallest trace of injury.

† We have shewn that these nervous symptoms only appear when the phosphorus has undergone a great degree of division.

destruction of the irritability of their muscles, exhibits an incontestable proof, that phosphorus, in a certain state, is possessed of a deleterious property, and destroys vitality by destroying the nervous power. 5th. That water, which does not dissolve phosphorus, produces slight, serious, or fatal symptoms, according to the quantity of particles of phosphorus it holds in suspension.*

SYMPTOMS AND LESIONS OF TEXTURE PRODUCED BY PHOSPHORUS.

719. The symptoms and lesions of texture to which phosphorus gives rise, vary according to the state of division in which it happens to be when taken. 1st. If it be solid, in small cylinders, and the stomach be filled with food, the symptoms will not take place till some hours after it has been swallowed, and they will be in every respect similar to those which distinguish inflammation of the stomach and intestines.

2nd. If the phosphorus has been previously dissolved in oil or æther, whatever may be the state of the stomach, in a short time the most cruel sufferings, the most obstinate vomitings, and the most alarming symptoms, will make their appearance, and portend a speedy dissolution. It is evident that the lesions of texture will be more serious in this last case than in the former. (vide. exper. 3d and 5th.)

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY PHOSPHORUS.

720. It is impossible to confound pure phosphorus with any other body in nature. In short, its smell of garlic, its

* These experiments were made upon young cocks and frogs. (*Alibert, Nouveaux Eléments de Thérapeutique*, 3d. edit. tom. i. p. 174.)

other physical properties, that of smoaking in the air, its great fusibility, and its combustibility, are so many characters which will not allow of the smallest mistake on that score. (§ 710 et seq.)

721. If the poison is to be sought for after death; the intestinal canal ought to be examined, to see if it does not contain some solid pieces of phosphorus of a red colour, which may be known by the proceedings we have just pointed out. In case we should not be able to discover the least trace of this combustible body, we must collect together all the fluid and solid substances which line the stomach and intestines, in order to be assured whether they do not contain phosphorous or phosphoric acid, (p. 369 and 375) produced by combustion in the stomach.

TREATMENT OF POISONING BY PHOSPHORUS.

722. When the phosphorus has been taken in a solid state, the most pressing indication is to administer two or three grains of antimoniated tartrate of potash: by this means the physician will easily succeed in throwing up the poison before it has had time to act, or at least before it has produced any decided action. If it has been taken in a state of division, there is no doubt, but it will be extremely advantageous to cause the patient to take immediately copious draughts of water containing magnesia in suspension; for, 1st, these draughts will fill the stomach with fluid, will drive away the atmospheric air, and the phosphorus will be no longer able to burn with the same rapidity; 2nd, they will favour vomiting by distending the stomach, without adding to the irritation which the poisonous substance has already produced; 3rd, they will saturate the phosphorous or phosphoric acid that may be formed, and consequently hinder them from corroding the textures with which they come in contact.

If, notwithstanding all the assistance we have advised, inflammation of the first passages should declare itself, or the patient be attacked with alarming nervous symptoms, it will be necessary to have recourse, without delay, to the most powerful antiphlogistics and antispasmodics.

ARTICLE XIV.

GLASS AND ENAMEL, IN POWDER.

723. Ought glass, enamel in powder, and the different kinds of sharp angular stones, to be considered as substances capable of corroding the parts with which they come in contact; and ought they to be reckoned amongst the poisons of this class? We find in the annals of medicine, several facts relative to this important question; some of which tend to prove, that the sharp fragments of these stony substances may be swallowed with impunity; others, on the contrary, establish in the most positive manner the danger that exists from introducing them into any part of the digestive canal. *Caldani*, *Mandruzzato*, *M. le Sauvage*, and others, report experiments made upon men and animals, in which the ingestion of glass was not followed by any accident. *M. Portal*, *Fodéré*, &c. &c. speak in their works, of persons who have experienced the most serious symptoms from these bodies remaining in the digestive canal. We are of opinion that we should give in this article the most striking results obtained by these physicians; we shall afterwards pass on to the means proper for recognising glass finely powdered. It seems to us, that if there were but one well attested case of vitreous substances having produced any accident, we should be warranted to dedicate a few moments to their history. It is beside of importance to call the attention of the practitioner to this object, the attempts at poisoning by these substances being sufficiently frequent.

FACTS WHICH TEND TO PROVE THE INNOCENCE OF GLASS.

Experiment 1st. A full grown cat of large size was made to swallow a decagramme (2 drachms $\frac{3}{5}$) of glass, reduced to a coarse powder, and inclosed in a piece of crape; the animal did not shew any signs of suffering during the whole day.

The next day the same animal was made to swallow a like quantity of glass reduced to fragments, the size of half a line. During the three days which followed, the animal enjoyed excellent health: then a similar quantity of glass was administered, broken into fragments, which were about a line in length. The day after, the cat was made to swallow two fresh doses, and was in very good health fifteen hours after this last dose. Up to this time the fragments of glass had been easily recognised in the excrements, without having undergone any altération. The animal was opened, and the mucous surface of the intestinal canal was carefully examined throughout its whole length: it was impossible to discover in it the least trace of injury. The last doses of glass were found in the great intestine, confounded with the excrementitious matter. Several *tæniæ*, which were fixed in the small intestine, had not experienced any injury.

Experiment 2nd. Three dogs were made to swallow pounded glass; each one took from about eighteen to twenty decagrammes in the course of eight days: during the last four, one of them was made to take it without food; and, in order to send it naked into the stomach, the fragments were enveloped in gray paper wetted, with which boluses were made, which were introduced, by the assistance of the finger, to the bottom of the animal's pharynx. He only took food once in the day, and always eight hours after having swallowed the glass. He gave no more signs of uneasiness than the others, who had taken this substance mixed with their food.

Eight days after, two of these animals were opened: they did not exhibit any trace of injury throughout the whole length of the alimentary canal. The dog who had swallowed the glass without food, made his escape while the others were opening; and it could not be certainly ascertained, whether this substance, in passing alone through the digestive canal, had not produced some lesion. The experiment has been repeated since, and glass was given to two dogs during several days, in the manner mentioned above, and with the same precautions, without their having experienced any accident.

Experiment 3d. Three rats were submitted to the action of glass; it was five times given to them in the course of seventeen days; they took each time a considerable quantity, and many of the fragments were more than half a line long; every day their excrements were full of it. During this long interval they did not show the slightest symptom of uneasiness. They were opened and their intestinal tube did not discover the least trace of inflammation, or of lesion.

Experiment 4th. M. Le Sauvage, author of the experiments we have just related, swallowed, on the 8th of March, 1809, fragments of glass of a line in length, irregular, and more or less pointed; he took them indiscriminately, fasting, or after his meals, and always unmixed. He did not experience the least painful sensation, and has since repeated the experiment without any danger.

The author of this work concludes:

" 1st. That glass, and such like substances, do not exercise " any chemical action upon the digestive organs of living ani- " mals; and the fluid or gaseous substances contained in these " same organs, exercise no chemical action upon vitriform " substances.

2nd. " That it is from error, and relying upon prejudices, that " some authors, otherwise respectable, have thought that these " substances were possessed of peculiar and very active pro- " perties.

3d. "That the mechanical effects of irregular fragments of "glass upon the intestinal tube, have been rather imagined "than observed; and those of a powder more or less fine of "this substance are still less established.

4th. "That under a preconceived notion of these circum- "stances, which are probable enough, the facts which they "believed proper for demonstrating this opinion were col- "lected; and consequently, that these facts have not been ob- "served with a mind free from prejudice.

5th. "That of these same facts, some are not authentic; "not having been seen by those who report them; and in "others there are found the evident symptoms of well known "diseases.

6th. "That it is no difficult task in the present day to pro- "duce numerous instances of the ingestion, not only of glass "and diamond, but even considerable fragments of these same "substances, which have been swallowed without accident.

7th. "That experiments intentionally made upon living "animals, place it beyond a doubt, not only that these sub- "stances are incapable of injuring mechanically the aliment- "ary canal, but even that they do not produce the slightest "irritation.

8th. "Lastly, that an experiment which any person can "easily make, and without any danger, upon himself, proves "that these substances do not produce even any painful sen- "sation."*

ACCIDENTS OCCASIONED BY GLASS INTRODUCED INTO THE ALIMENTARY CANAL.

M. Portal, in his work on mephitic vapours, quotes a case which deserves to be here reported.

"I have seen," says he, "a young man who did not fear to

* Dissertation soutenue à l'Ecole de Médicine de Paris, par M. Le Sauvage, Aôut, 1810.

challenge his comrades, in a drinking party, to swallow a part of the glass he had been using to drink out of: in fact, he broke his glass into fragments with his teeth, and immediately swallowed them; but not with impunity. He felt in a short time a terrific cardialgia; to which succeeded convulsive motions; and great apprehensions were entertained for the life of this young man, when his friends called in my assistance. He was first bled; but the main object was to extract from the body the glass which gave rise to the symptoms: the means to effect this embarrassed us not a little. On one hand it was perceived, that the tartar emetic would increase the irritation and contraction of the stomach, and that the glass would insinuate itself deeper into its coats; while on the other hand, purgatives would only push on the glass into the intestinal canal, the long extent of surface of which, would, in all probability have been excoriated. It was judged necessary to advise the patient to fill his stomach with some kind of food, which might serve as a recipient for the glass, and afterwards he should be made to vomit. Some cabbages were in consequence procured and boiled; the patient ate a considerable quantity of them, and he was afterwards made to swallow two grains of stibiated tartar (emetic tartar) in a glass of water. The patient soon after vomited, and threw up, amongst the cabbage he had eaten, a considerable quantity of glass: he was afterwards made to drink plenty of milk; he was put into the bath; glysters were administered to him; and as, notwithstanding this methodical assistance, he had fallen into a considerable degree of emaciation, he was recommended the use of asses' milk, which indeed he took for more than a month, and which restored him to his former state of health."

A man insinuated up the fundament, a drachm glass with a bell mouth, as high as he could, for the purpose of cooling those parts. For fifteen days he experienced a very trying, but not painful sensation. The want of going to stool obliged

him to discover his situation to a surgeon, who, from want of dexterity, contrived to break the glass into two pieces in attempting to extract it: one of the pieces remained in the rectum. The angular edges of this broken glass insinuated themselves into the coats of the intestine, in so tenacious a manner, that it became impossible to extract it by any other method than by counter-openings, to which the patient refused to submit. The consequences were, excruciating pains, which nothing could relieve; and several fistulous and gangrenous abscesses, of very great extent, under which the patient in the end could not do otherwise than sink in a short space of time. Now if a piece of glass had fixed itself in the stomach, or in any other part of the digestive canal, is it to be believed that the symptoms would have been less, or rather, would they not have been more violent and more rapid? *

M. Marc, in a work entitled *Manuel d'Autopsie Cadaverique Médico Légale*, says, "The observations which medical "men have had opportunity of making upon the eaters of glass, "and a few recent experiments of *Caldani* and *Mandruzzato*, "which appear all to decide in favour of the innocence of "these kinds of substances, have been too lightly adopted. "*Caldani* made experiments upon animals, and even (what "appears difficult to conceive,) upon a young man of fifteen "years of age, whom he caused to swallow pounded glass, "without his having experienced the slightest inconvenience. "*Mandruzzato* repeated these same experiments upon animals "and upon himself, and obtained the same results. These "observations however prove, at most that pounded glass "introduced into the stomach, is not always hurtful; and such "isolated facts by no means prove, that in other cases, and under "different circumstances, one or more sharp points applied to "the internal surface of the alimentary canal, might not pro-"duce there a mechanical action of the most fatal kind. It

* Fodéré Op. Citat. page 113. tom. iv.

" is, moreover, clear, from the fate which terminated the ex-
" istence of the most experienced of these glass-eaters, who
" almost all died of intestinal diseases, (*Ploquet sur les Morts*
" *Violentes*,) from the different sudden deaths after swallowing
" of glass (*Gmelin in his History of Mineral Poisons*, and
" *Metzger*); that these kinds of substances may be extremely
" dangerous."

724. The physical properties of glass in fragments, are sufficiently well known, to render it unnecessary to detail them. If the presence of this substance finely powdered were to be determined, we should melt it in a crucible, or what is still better, upon a piece of charcoal, by the assistance of a blow-pipe: in a short time a lump of glass would be obtained, whilst, at the same time, the organic substances with which it may have been mixed, would be decomposed by the calcination.

ARTICLE XV.

SPECIES XV.—CANTHARIDES.

Synonym. Cantharides of the shops. *Cantharis Vesicatoria—Meloe Vesicatorius—Lytta Vesicatoria;* a kind of insect of the family of Cantharides, Order Coleoptera, Class Pterodicera. (Latreille.)

Cantharides have the body elongated, almost round, or cylindrical, two wings covered by hard, but flexible *Elytra*, the *antennæ* are black and filiform, half the length of the body, and composed of eleven joints, longer than they are broad, and the last of which is elongated and sharp; the head inclined; the mouth furnished with a superior lip, two simple mandibles, arched, two bifid *maxillæ*, and four filiform *antennulæ;* five joints to the *tarsi* of the four anterior legs, and four to those of the posterior.

PHYSICAL AND CHEMICAL PROPERTIES OF CANTHARIDES.

775. Cantharides, according to M. Robiquet, contain:

1st. A green fluid oil, insoluble in water, soluble in alcohol, and by no means vesicatory.

2nd. A black matter, soluble in water, insoluble in alcohol and possessed of no vesicatory property.

3rd. A yellow matter, soluble in water, and soluble in alcohol, at the ordinary temperature, not vesicatory.

4th. A white substance, in the form of small crystalline plates, insoluble in water, (soluble however in this fluid, when it is mixed with the yellow matter,) soluble in boiling alcohol, in which it subsides on cooling, in crystalline flakes, after the manner of spermaceti; soluble in the oils, strongly epispastic.

5th. A fat matter, insoluble in alcohol, not epispastic.

6. Phosphate of lime, which forms the basis of the skeleton.

7th. Phosphate of magnesia.

8th. A small portion of acetic acid.

9th. A greater quantity of uric acid.*

* The existence of the four first matters in cantharides, may be proved by following the precise process of M. Robiquet.

1st, Cantharides must be boiled in distilled water, being previously slightly powdered; by this method a fluid, L, of a brown red colour is obtained, in which are contained the black, yellow, and white matter: the residuum, R, is formed of the green oil, the fat matter, and the solid substance of the skeleton.

L, being evaporated to the consistence of an extract, and treated by boiling alcohol, leaves behind the *black* matter, which is insoluble in this menstruum, and furnishes a solution, from which may be obtained by evaporation, the yellow and white matter. In order to separate these two substances, they must be agitated for several hours with rectified sulphuric æther; they then grow soft, divide, and impart a yellow tinge to the æther. This must be decanted into a porcelain saucer, and there will soon be seen, in proportion as the fluid evaporates, some shining particles clouded by

726. Cantharides may be reduced to a fine powder, of a greenish gray colour, mixed with some shining points of a very beautiful and very bright green, in every respect resembling that of the insect when whole. The smell of this powder is acrid and nauseous.

727. When thrown on burning charcoal it decomposes after the manner of animal substances, gives out a smoke of a fetid smell, and leaves a charcoal for a residuum.

728. River water poured upon this powder, becomes of a yellow colour.

729. Sulphuric Æther, mixed with the fine powder of cantharides, acquires instantly a greenish yellow tinge.

730. If alcohol is allowed to remain upon this powder, the fluid quickly acquires a yellow, or a red colour, in proportion to the degree of concentration of the alcohol, and the time it has had to act: in this state it is known by the name of *spirituous tincture of cantharides*, which is commonly prepared in the shops with ordinary brandy instead of alcohol.

731. The spirituous tincture of cantharides (of the shops) furnishes with water, a white milky precipitate, which is soluble in an excess of this fluid; the solution however preserves a whitish tinge slightly inclining to opal.

732. The infusion of tournesol slightly reddens it, and produces in it a precipitate of a clear rose colour.

minute drops of a yellowish fluid. When the evaporation of the æther is terminated, the residuum must be treated with cold alcohol, which dissolves all the yellow matter, without attacking sensibly the small crystalline flakes.

R, being boiled in alcohol, furnishes a tincture in which the green oil will be found to be contained, and which is easily separated by evaporating the alcohol. (*Robiquet, Annales de Chymie*, tom. xvi.)

The separation of the different principles of cantharides, and the determining the proportions in which they are united, require more complicated proceedings, which cannot be explained in a proper manner without entering into chemical details, which are incompatible with the plan we have adopted.

733. The prussiate of potash causes it to pass to a canary yellow, renders it turbid, and throws down, in the course of a few moments, a white, and, as it were, earthy precipitate, slightly inclining to yellow.

734. The hydro-sulphurets of potash, soda, and ammonia, precipitate the tincture of cantharides in great clots of a clear yellow colour.

735. The solution of sub-carbonate of potash causes it to pass to a yellow; and produces in it, in the course of a few seconds, a pulverulent precipitate of a beautiful white colour.

736. The sulphuric and muriatic acids, poured upon the tincture of cantharides, render it suddenly turbid, and cause it to pass to a canary yellow colour: the precipitate when collected is of a greenish yellow, and appears under the form of excessively small scales. The nitric acid causes in it a yellow precipitate, and at the end of twenty hours, there is observed to appear upon the surface of the fluid, a reddish oily matter, the smell of which resembles that of fat treated by nitric acid.

737. The infusion of tea produces in it a grumous precipitate in very great abundance, and of a yellowish white colour.

ACTION OF CANTHARIDES UPON THE ANIMAL ECONOMY.

738. Cantharides, when brought in contact with our texture, very soon produces symptoms the most serious, almost always followed by death. What is their mode of action?

Experiment 1st. Two drachms of the spirituous tincture of cantharides were injected into the jugular vein of a small dog;* the animal instantly experienced vertigoes, and when made to walk, he staggered, and resembled a person drunk

* The tincture employed in these experiments was prepared with alcohol at 24, and the coarse powder of cantharides.

with wine. At the end of five minutes he vomited, at three successive times, a small quantity of food mixed with a yellowish fluid, of a bilious appearance. Ten minutes after, the vertigoes ceased, and the animal was perfectly restored.

Experiment 2nd. Four drachms of the tincture of cantharides were injected into the jugular vein of a small dog. Scarcely had the injection been accomplished, when the animal fell into such a state of stupor that he was thought to be dead. One minute after, he made a strong respiration, and expired without uttering the least plaintive cry, and preserving the same position in which he had been during the ingestion. The body was immediately opened: the blood contained in the left ventricle of the heart was fluid and reddish; that which filled the right ventricle was black, and presented a few small clots.

Experiment 3rd. Wishing to know what influence the alcohol had exercised in these two last experiments, four drachms of pure alcohol at 24°, were injected into the jugular vein of another small dog. A few seconds had hardly elapsed after the injection, when the animal fell, without a possibility of observing the slightest symptom in this rapid passage from life to death.

Dissection instantly took place. The blood contained in the left ventricle was fluid and reddish, that which occupied the right was black, and exhibited several clots of a gelatinous appearance. Being convinced from these experiments, that it was necessary to renounce the spirituous tincture for the purpose of determining the mode of action of cantharides upon the animal economy, recourse was afterwards had to oil, which had been previously heated with the powder of this insect.

Experiment 4th. At ten o'clock, there were injected into the jugular vein of a dog of middle size, a drachm and half of oil of sweet almonds, which had been heated for a quarter of an hour with a drachm of powdered cantharides. At the end of two minutes the animal lost his senses; he lay down upon

his side, and it was impossible to make him stand upon his legs. A few moments after, he experienced a general stiffness, accompanied by a great agitation in all his limbs; the head was strongly bent backward; the breathing was not impeded. This state of things continued for six minutes; then the convulsive movements ceased, the breathing became accelerated; the animal uttered no plaintive moan; he preserved the same position as before. Ffteen minutes after the injection, an attempt was made to raise him up; but he fell at once upon his head, beginning again to agitate his limbs. At a quarter before eleven, he had a most violent convulsive paroxysm, during which his breathing was very much accelerated: the animal uttered a few plaintive cries, rolled his body on the ground, and fell again on his head. At twelve o'clock his breathing became extremely difficult and sonorous. He died at half past one, having passed urine twice since the moment of the injection.

The lungs were very bulky, and distended with a great quantity of reddish serosity: they exhibited several portions of a livid red colour, of a compact substance, and but little crepitating; the other parts of this organ were in their natural state. The mucous membrane of the bladder was slightly injected; that which lined the stomach and duodenum shewed nothing remarkable.

Experiment 5th. At twelve o'clock at noon, the œsophagus of a dog of the middle size was detached and perforated; three drachms of the tincture of cantharides, in which were suspended eight grains of the powder of this same insect, were then introduced into the stomach, and the œsophagus was tied below the opening to prevent vomiting. An hour after, the animal appeared to suffer pain; he made great efforts to vomit, and fell into a state of great dejection and extraordinary insensibility. He died the next day at noon, after having thrice passed urine.

The mucous membrane of the stomach was of a fiery red

throughout its whole extent: that which lined the duodenum though rather less red, was evidently inflamed. The bladder contained no urine; its interior coat was of a fiery red, and had acquired a remarkable thickness.

Experiment 6th. At eleven o'clock a small dog was made to swallow thirty grains of cantharides coarsely powdered; immediately after, the œsophagus was detached and tied. In the course of six minutes, the animal began to make violent efforts to vomit; he experienced a great general uneasiness, and fell into a state of dejection; his mouth was filled with bloody mucosities. At one o'clock he still continued to make efforts to vomit, which he had scarcely ever ceased to do since the moment of the ingestion of the cantharides. He expired at half past four, without having passed the smallest quantity of urine.

The mucous membrane of the stomach was of a black red throughout its whole extent; that which lined the duodenum and jejunum was rather less inflamed. A small quantity of the powder, which the animal had taken, was found upon their surface. The lungs exhibited no alteration. The bladder and parts of generation were in their natural state.

Experiment 7th. A dog of middle size was made to take forty-eight grains of powder of cantharides. At the end of an hour the animal vomited a small quantity of greenish matter; he uttered very plaintive cries, and appeared to suffer much pain. He died in this state about four hours and a half after the poisoning. He was immediately opened. The blood contained in the ventricles of the heart was found not coagulated; the lungs presented no remarkable injury: the bladder was in its natural state; the stomach contained within it a small quantity of greenish powder; its mucous membrane was of a very strong red colour.

Experiment 8th. A dog of middling strength was made to take a drachm of cantharides; a short time after there flowed from his throat a great quantity of mucosity; he experienced

retchings followed in a short time by copious vomitings. He howled occasionally as if in pain, had the appearance of dejection, could with difficulty drag himself along, and threw up from time to time a yellowish matter. He passed urine three times in the course of the day, and had no sign of swelling about the penis. Towards night, the vomitings ceased, the dejection continued, and he died during the night.

The inferior third part of the œsophagus was red in its interior surface: this colour, which was more decided on the exterior surface of the stomach, was much deeper within side this viscus, which contained also reddish mucosities. Its internal membrane presented, especially at its great curvature, some inflamed points as broad as a bean; these spots were extended some little distance into the small intestine, which was likewise covered with mucosities of the same colour as those of the stomach: the bladder, which was greatly contracted, contained no urine; its mucous membrane, as well as that of the urethra, shewed no signs of inflammation: the blood contained in the veins, and in the right cavities of the heart, was greatly coagulated.

Experiment 9th. An old dog, nearly of the same degree of strength as the preceding, was made to swallow a drachm of cantharides in powder; a few minutes after, he threw up a small quantity of it, mixed with some mucosities. During the first hour which followed the ingestion of the poison, he had four times a great inclination to vomit; at the end of this period, he experienced a shivering, and convulsive movements, especially in the thoracic and abdominal region: he remained lying down upon the side, with his eyes cast down, and appeared to be suffering the most severe pains: he vomited some reddish matter, and died four hours after having taken this dose of cantharides.

The throat, fauces, and tongue, were covered with a sort of white rind, easy to detach with a scalpel; the surfaces underneath this rind were of a deep red colour. The œsopha-

gus, which was very red on its external surface, exhibited in its interior, a number of inflamed spots, which were more numerous near the cardia: the stomach, on its external surface, was strongly inflamed, particularly at its great curvature; its interior contained a fluid of a violet red colour, mixed with cantharides; its mucous membrane, which was of a purple red, came off in pieces, especially in the great curvature.

The small intestine exhibited on its external surface only a slight trace of inflammation: its internal membrane, scattered over with red streaks, was lined with a mucus of the same colour, extending to the rectum, which was slightly inflamed.

The blood contained in the veins and the right cavities of the heart, was extremely coagulated.*

Experiment 10th. A wound was made on the back of a small dog, which was sprinkled with a drachm of cantharides, finely powdered, and the flaps were united by four stitches. Five hours afterwards the animal vomited a small quantity of yellowish matter, somewhat thick, and refused to eat. The next day, towards evening, he was much dejected, he suffered a great deal of pain, and discharged at three different times a small quantity of urine, highly coloured. He died thirty-two hours after the poisoning. The wound was very much inflamed; the redness extending far beyond the points where the cantharides had been applied. The bladder contained no urine; its internal coat was evidently inflamed, and very red. The stomach contained only a small quantity of a yellowish fluid; its mucous membrane appeared to be rather redder than in its natural state. The lungs were sound.

It follows from all these facts: 1st. That the part of cantharides soluble in oil of sweet almonds, when injected into the veins, in no very strong dose, exerts its action upon the nervous system, and principally upon the vertebral column.

* Experiments 8th and 9th, were made by M. Beaupoil (*Recherches Médico-chimiques sur les Vertus et les Principes des Cantharides*: Dissertation Inaugural, in 8vo. Paris, 15 Fructidor, year 11.)

2nd. That when this insect is introduced into the stomach, it acts as a corrosive, and occasions death in a very short time, by inducing a severe inflammation of this viscus, and acting upon the nervous system;* it produces likewise, inflammation of the internal coat of the bladder, when it remains in the stomach a few hours before life is destroyed. 3d. That when it is applied externally, it destroys animals sometimes by the same kind of action which it exerts when introduced into the stomach.†

SYMPTOMS OF POISONING BY CANTHARIDES.

OBSERVATION 1st.

"In 1572," says Cabsol, "we went to visit a poor man in Provence, who was attacked by the most horrible and formidable *satyriasis* that one could see or imagine:—the fact is this: he was labouring under a quartan fever; to cure which, he took the advice of an old sorceress, who made him up a draught of the seeds of nettles, and two drachms of cantharides, and other things, which produced such a degree of satyriasis as proved fatal, in spite of all the medicines administered."‡

* The nervous symptoms have not been very remarkable in those animals, which formed the subjects of the experiments we have just described; but a glance over the observations we are about to detail, (the 3rd and 4th,) will be sufficient to convince any one, that in this disease the nervous system is indeed sympathetically excited.

† M. Robiquet has demonstrated, that the white crystalline substance of cantharides alone possesses the epispastic property. We cannot flatter ourselves that a satisfactory work will be produced on the mode of action of this insect, until the effects of the different substances of cantharides separately, injected into the veins, introduced into the stomach, or externally applied, shall have been determined. I have undertaken, on this subject, a series of experiments, which I propose to publish as soon as they appear to me to be complete.

‡ The original of the above case, and the succeeding one, are written in a style of so little decency of expression, that the translator has judged it proper to abridge them, and alter the language, rather than insult the delicacy of his readers by a literal translation.

The same author reports, that M. Chauvel, a physician of Orange, was called in, in 1570, to Caderousse, a small town near his residence, to see a man who was attacked by the same disease. " On entering into the house, he found the wife of the above patient, who complained to him of the furious salacity of her husband, whose disease had originated from a draught similar to the above, which was given to him by a woman who attended on the hospital, in order to cure him of a tertian fever that afflicted him; in consequence of which, he fell into such a fever, that he was obliged to be tied as one possessed of the devil. The vicar of the place was present, in order to exhort him, in the presence of the said M. Chauvel; to both of which he begged that he might be allowed to die with the pleasure which he then enjoyed. The women of the hospital wrapped him up in a linen cloth, wetted with vinegar and water, where he was left until the next day, when they went to visit him; but his furious heat was pretty well reduced and extinguished, for they found him stiff and dead, his mouth still smiling, and his penis in a state of gangrene." *

OBSERVATION 2nd.

An abbé, of middle age, being in this town, on account of a law-suit, solicited, at the same time, a woman of bad reputation, to be allowed to pass a night with her, and immediately on concluding the bargain, arrived at her house. She received him kindly; and wishing to gratify him, gave him, by way of collation, a certain sweetmeat, into the composition of which cantharides entered, in order to excite him the more to the venereal act. A short time afterward, that is to say, the next morning, the symptoms which I have above described, occurred to this abbé, and still more violent, since he passed pure blood

* Dissertation sur le Satyriasis, par M. Duprest-Rony, soutenue à l'Ecole de Médecine de Paris, le 10 Germinale, an 12.

both by stool and urine.* Physicians being called in, and seeing the abbé labouring under such symptoms, with an erection of the penis, knew, at first sight, that he had taken cantharides. They ordered him emetics, and glysters made of pearl barley, rice, and decoction of manna, linseed, fenugreek, oil of lilies, goat's or stag's lard; and then afterwards a small quantity of theriaca, mixed up with conserve of roses, in order to expel the poison from the body; for the same reason, they gave him milk to drink, and administered injections to the penis and intestines, with other refrigerating and mucilaginous articles, in order to correct, obtund, and destroy the virulence and malignity of the poison. His drink consisted of barley ptisan; his eating, of fowls, veal, kid, fat pigs boiled with lettuces, pot-herbs, &c. which food served him likewise as medicine, as well for relaxing the bowels, as for relieving the pains arising from the acrimony of the poison: and on the region of the kidneys, loins, and perinæum, were applied several refrigerating articles; beside which, the warm bath was employed, in order to drive out the poison from the pores of the skin: but notwithstanding all these remedies, applied according to art, the abbé died of gangrene of the penis.†

OBSERVATION 3rd.

N***, a young lady, fifteen years of age, of a bilious temperament, and a strong constitution, being in a state of despair on account of finding herself without any means of existence, swallowed, on the 12th of June, 1812, about eight grains of the powder of cantharides; a few hours after, she felt a very severe pain in the hypogastric region, a burning heat with itching in the parts of generation, and a constant want to make

* These symptoms were,—a severe pain in the stomach and in the bladder; a looseness, similar to that of dysentery; an ardent fever, vertigoes, &c.

† Œuvres d'Ambroise Paré, liv 21, des Venins, douzieme édition, p. 500.

water, which she could only accomplish drop by drop, and with the most cruel suffering. A few moments afterwards, she became a prey to horrible convulsions; during which her limbs were contorted: she uttered piercing cries, and often lost her reason. *(Milk, linseed tea, camphorated emulsion, emollient glysters.)* These medicines put an end to the principal symptoms.

The following day she only complained of pains on making water, and a darting pain in the urinary passage; her urine was extremely red, and covered with small black pellicles *(the same treatment)*. On her entrance into the Hotel-Dieu, on the 26th of June, she exhibited no remarkable symptom; her health continued to improve; the stomach and intestines performed their functions freely. *(Edulcorated gum arabic, emollient glysters, boluses of camphor and nitre, eight grains.)* On the 30th, she experienced again a slight scalding on making water, which gradually went off in the course of a few days.*

OBSERVATION 4th.

A young man, about 21 years of age, of a very good constitution, and who had been subject from his infancy to convulsions, known by the name of *eclampsia puerorum*, swallowed a few drops of *tincture of cantharides:* at the same instant he felt a burning of the lips, tongue, and membrane of the palate. In spite of all the efforts he made to spit out the caustic liquor from his mouth, the mucous membrane was inflamed in a few hours; and a considerable tumour made its appearance in that part, with a copious ptyalism. He took, by the advice of a surgeon, some milk, and a great quantity of emollient drinks: notwithstanding the use of these means, he experienced from time to time, scalding pains at the pit of the stomach, and in the midst of the umbilical region. At the

* Observation communicated by Doctor Piquet de la Hoursiette.

end of three days, after having supped as usual about an hour before midnight, he was all at once seized with horrible convulsions: at one time he threw himself down, and rolled on his bed in despair; at another, he rose up, and darted like a madman towards the bed of one of his friends, who slept in an alcove in the same room; seized hold of the iron curtain rods of his bed, and bent them like a cane, uttering the most horrible cries and bellowings: eight of the strongest men could scarcely hold him. To these convulsions were joined a completely furious, and almost phrenitic delirium: the convulsions gave him some intervals, but the delirium continued without intermission. The physician who reports this case, saw him at 10 o'clock in the morning for the first time; he found him in a terrible situation: the convulsions followed each other almost without interruption: the paroxysms continued for two hours together: afterwards succeeded a calm of a few minutes. At one time they assumed the form of *emprosthotonos*, at another time, that of *opisthotonos;* at one time he opened his mouth, at another time a violent *trismus* closed his jaws, with very strong gnashing of the teeth, and a flow of frothy saliva from the mouth, mixed sometimes with streaks of blood: his countenance bore the marks of terror and despair. During the convulsions, the hairs were seen to stand on his head; his looks were fixed, his eyes were bright and sparkling, and their muscles, which were affected successively by convulsion, produced in the globe of the eye a horrible rolling. The heat of the skin was natural; the pulse expanded, and slow, gave only fifty-five pulsations in a minute. On laying the hand upon the umbilical region, and making a little pressure, the abdominal muscles contracted; the abdomen appeared entirely obliterated in the middle, and the muscles to be glued to the spine, especially the *recti*, which had the stiffness of a cord on full stretch; all at once the commotions were communicated to the whole body, the convulsions became general, and the head was bent back in a most horrible man-

ner. We wished to apply to the part most in pain, a sponge dipped in fat soup, and very hot: at that moment the furious patient darted forward, the saliva flowed in greater abundance and more frothy; his eyes became more ferocious; the constriction of the throat almost amounted to suffocation; he howled terribly, something like a dog: and immediately after these symptoms he fell into general convulsions, which ended by fainting or profound sleep.

Similar paroxysms frequently returned:—the least touch on the throat, or pressure on the most painful parts of the belly, and even the sight of water, or of soup, re-produced them. As it was impossible to make him swallow any thing, and equally so to inject any thing into the large intestines, a liniment was prepared, composed of a pound of the oil of olives, three drachms of liquid laudanum, the same quantity of ammonia, and a hundred grains of musk; it was recommended to rub with this liniment the whole spine of the back, from the neck to the os sacrum; the whole of the belly, and particularly the parts in pain; the whole of the throat, the arms, and thighs. These frictions, which were repeated every quarter of an hour, were prolonged for some time, and the patient was wrapped up in blankets well heated. The frictions were commenced at eleven o'clock; eight hours afterwards, he appeared more tranquil, and the paroxysms that occurred were shorter and less violent; he complained in the interval of one of these paroxysms, of a severe pain in the interior of the throat; it was examined, and a slight redness discovered there, extending from the superior and posterior part of the membrane of the palate to the muscles of the *velum palati* and to the uvula. We wished to make him swallow a small spoonful of oil: he instantly experienced violent constrictions, and struggled much; but at length he succeeded in swallowing this little oil without either the sight or the taste of this fluid reproducing the convulsions and other symptoms before described.

Taking courage from his beginning to swallow some small

doses of this fluid, we mixed with it tincture of opium, musk, and even native cinnabar, in very strong doses, which were given to him every half hour. During the night, they succeeded in making him take some small quantities of soup: from seven o'clock he recovered almost entirely the use of his senses. At eleven o'clock at night it was told him that one of his friends was under the necessity of going away: this news produced a strong emotion; a violent paroxysm shortly after made its appearance, it was accompanied with horrible convulsions, and lasted an hour and half almost without intermission. The hydrophobic symptoms however did not return, and after tranquillity was established, he complained again of a violent thirst; he drank in the night a great quantity of soup, reckoned by the assistants at more than twelve pints: he also slept. Towards five o'clock in the morning, he had a fresh attack, the duration of which did not exceed half an hour: the pulse was quiet; he still complained of an obscure pain about the navel, and in the throat. The frictions were continued every half hour. The next day he was much better. A spoonful of oil containing opium and musk, was ordered to be administered every half-hour; but he swallowed at once, the doses which ought to have served all the day, that is to say, one hundred and twenty drops of thebaic tincture, and eighty grains of musk, mixed with eight ounces of oil. No alteration either of pulse or in the heat of skin succeeded. He continued to take, during the day, a great quantity of water, soup, and wine; his appetite returned; they prepared him a hash of fowl of eighteen ounces in weight, and of strong and nourishing soup, which he ate with great pleasure. The whole of the day was passed very quietly without any convulsive attack, or fainting: he was merry and playful, which was probably owing to the impression of the opium and musk. The following night he had a peaceable sleep of a few hours; he continued to drink freely of the soup, and expectorated a small quantity of mucus, streaked with blood. In the following day,

he had several copious greenish evacuations; all the symptoms were quieted; the patient continued the frictions, and to eat and drink. Two days after, he quitted his bed, and no longer observed any regimen.*

OBSERVATION 5th.

M. F***, a young man of eight and twenty, or thirty years of age, was brought to the Hotel Dieu of Clermont Ferrand, in the night of the 24th of February, 1800, in the most deplorable condition: he rolled himself on the floor of the piazzas, uttering the most piercing cries. After repeated interrogations, we were informed, that he had been made to take, about an hour before, some drink, into which cantharides had been purposely introduced. F***, in a short time afterwards, began to feel a burning heat in the throat, and a very severe pain about the stomach. These symptoms grew rapidly more serious, and when brought to the hospital, he experienced besides, an excruciating pain in the region of the kidneys, and in the hypogastrium, and laboured under a very severe priapism. His voice was feeble and tremulous, his breathing laborious; pulse small, and concentrated. He felt an ardent thirst; but so great was the constriction of the throat, that it was impossible to introduce the least drop of any fluid without giving rise to the most inexpressible sufferings. Various kinds of drinks were tried, but without success. In a short time F*** evinced a very great aversion to liquids: when any were offered him, he pushed them off violently. In the mean time the symptoms went on increasing; the pains in the bowels became dreadfully severe; and he had tenesmus, with frequent desire to make water, but could only pass, after the most painful efforts, a few drops of blood by the rectum and by the urethra. Some injections of oil of almonds warm,

* Mémoirs de l'Academie de Turin, annés 1802 et 1803, Histoire d'un Tétanos avec Symptomes d'Hydrophobie, produit par les Cantharides Observ. rapportée par M. Giulio, p. 15.

were introduced into the bladder, and we succeeded even in making him retain about half of a glyster of oil of olives: large cataplasms were applied to the neck, and he was made to use some emollient fumigations; a short time after, he was made to swallow a few small spoonfuls of oil, but still with great difficulty. An attempt was made to put him into the warm bath, but in vain; scarcely had he entered it, when the pains appeared to become more violent, and he was obliged to be hastily withdrawn. Nevertheless a fresh attempt was made about an hour after, and not without success: the patient remained about twelve minutes in the water; on coming out, his sufferings appeared a little less severe, although the priapism, bloody urine, and pains of the bowels continued. Deglutition became rather less difficult, and we availed ourselves of it to make him swallow, at several different times, some oil of sweet almonds, or milk, or else some emulsion. By continuing these means, and having recourse to the warm bath now and then, we had the satisfaction to see the symptoms become moderate in the course of the day. The next day there was a very violent heat felt along the course of the digestive canal; the priapism continued to appear at longer and longer intervals; the blood from the urethra had ceased, but the emission of urine was still accompanied with great pain; he had had no stools. The symptoms went on decreasing; and on the sixth day, F*** left the hospital; but he retained for some time a sort of irritation in the stomach, and particularly in the throat. For several months he experienced a difficulty in the swallowing of liquids.

More correct details of the transaction made it appear that he had been made to take a drachm of the powder of cantharides in a half glass of Bourdeaux wine.*

OBSERVATION 6th.

Ambroise Paré relates, that having applied a blister over the

* Observation communicated by Dr. Biett.

whole face of a patient, with intention of removing some large pimples, the most serious symptoms were the consequence of it. " And three or four hours after the blister had produced " its effect, she experienced a wonderful heat at the bladder, " with great swelling about the neck of the matrix, and con- " siderable tenesmus; she vomited, passed stools, and urine " incessantly, tossing herself about, as if she had been in a " fire, and appeared to be out of her senses, and labouring " under a fever: which things at that time astonished me " much. And perceiving that these symptoms had arisen " from the cantharides, which had been applied for her blis- " ter, I advised that she should be made to drink milk in " great abundance, and that glysters and injections should be " administered, as well to the neck of the bladder, as to the " matrix. Wherefore she was put into water moderately hot, " in which had been boiled linseed, mallows, marsh-mallows, " poppies, lettuces, &c. and was kept in for a sufficient space " of time; by which means she got rid of her pains. Then " being placed in bed and dried, there was applied to the " region of the loins, and parts of generation, *unguentum*, " *rosaceum*, *populéum* incorporated with *oxycrate*, in order " to restrain the extraordinary temperature of these parts. " And by these means the rest of the symptoms were re- " lieved." *

The following are the symptoms of poisoning by cantharides: a nauseating and infectious smell, an acrid disagreeable taste, retchings, copious vomitings, abundant and frequently bloody alvine evacuations; very violent epigastralgia, horrible gripes, and excruciating pains in the hypochondria: heat in the bladder, urine sometimes bloody; an obstinate, and exceedingly painful priapism; pulse frequent, and hard; a very disagreeable sensation of heat, and ardent thirst; sometimes a horror of liquids, frightful convulsions, tetanus, delirium, &c. &c.

* Paré Op. Citat. p. 500.

LESIONS OF TEXTURE PRODUCED BY CANTHARIDES.

739. The lesions of texture, resulting from the action of cantharides upon the digestive canal, are extremely similar to those of the other corrosive poisons. Fungous tubercles are sometimes seen on the internal coat of this canal, with varices and ulcerations.* It does not appear at all doubtful, that they give rise likewise sometimes to inflammation of the mucous membrane of the bladder and parts of generation: this kind of injury takes place more particularly when the patient only dies one or two days after the poisoning.

APPLICATION OF ALL THAT HAS BEEN SAID TO THE CASES OF POISONING BY CANTHARIDES.

740. It will be always easy to distinguish cantharides, when a portion of the powder not taken can be procured. In fact, whatever be the state of division of this powder, even when it shall have been passed through a silken sieve, it will be possible to discover, by an attentive examination, a number of shining points, of a very beautiful green colour; and when treated by the different chemical agents, the results described from § 727 to § 737, will be obtained. The same method must be had recourse to in those cases where they must be

* In 1787, two brothers, having swallowed, in a frolic of debauchery, powdered cantharides, diluted in chocolate, one of them died in the course of three weeks, of dysentery; and the one who survived expired about ten weeks after, in the most dreadful agonies, at Paris, whither he had repaired for assistance. On opening the body, the stomach and part of the duodenum were found scattered over, on their interior surface, with fungous tubercles, varices, erosions, and little ulcerations. The kidneys and bladder exhibited nothing else deserving of notice. (*Recueil Périodique de la Société de Médecine de Paris*, tom. x. No. 56.)

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sought for in the matter vomited, or in the contents of the stomach after death. If the characters furnished by the re-agents should differ from those I have described, the practitioner must pay no regard to them, in deciding on the presence or absence of cantharides; for animal substances present in the different menstrua very complicated phenomena, which are little understood, and consequently liable to lead into error. In this case, he must attend simply to the physical properties of the powder, to the lesions of texture, to the symptoms, and the history of the case.

TREATMENT OF POISONING BY CANTHARIDES.

741. We have not yet acquired a sufficiently extensive knowledge of the nature of the principles composing cantharides, and animal substances in general, to be able to flatter ourselves with the hope of tracing out successfully the antidotes of the different poisons which they furnish. For which reason we are obliged to refer the reader, for the treatment in question, to all that has been said generally in the different articles, on the other corrosive substances, reminding him particularly of the advantage to be derived from the exhibition, in the first moments, of gentle emetics, such as oil in large quantities. Barthez has employed sometimes with success, an emulsion of milk of almonds, and syrup of diacodium. M. Giulio, in the case of tetanus which we have given, obtained great advantages from friction with a liniment composed of oil of olives, liquid laudanum, and ammonia; he employed also a tincture of musk and opium. The details into which we have gone in describing the treatment of each of the persons who form the subjects of the foregoing observations, do away the necessity of our dwelling any longer on this subject.

CHAPTER II.

Class 2nd. ASTRINGENT POISONS.

742. The astringent poisons are so called, because they frequently produce a remarkable constriction of the great intestines, and especially of the colon. We shall perceive however in the end, that they are capable of producing inflammation of the texture of the digestive canal, and that they frequently exert their action upon the nervous system. We rank in this class only the saturnine preparations.

ARTICLE I.

SPECIES I.—THE COMPOUNDS OF LEAD.

Var. 1. Acetate of lead.
2. Red oxyde of lead, litharge.
3. Carbonate of lead. Cerusse.
4. Wines sweetened by lead.
5. Water impregnated with lead.
6. Food cooked in leaden utensils.
7. Syrups and spirits clarified with acetate of lead.
8. Saturnine emanations.

743. If we were to judge of the interest excited by any medical subject, by the number of writings to which it has

given birth, we could not but regard the poisoning by lead, as the most important to be known of all those that have been treated of up to the present time. In fact, Hippocrates, Henckel, Stoll, Tissot, Bordeu, Sauvages, and many other celebrated physicians, have endeavoured to throw some light on certain points of the history of the colic occasioned by the preparations of lead.

These illustrious practitioners, astonished at the frequency and severity of the diseases to which the particles of this poison give rise, have endeavoured to examine, in their classical works, or in monographs, into all the objects connected with it. Their labours have frequently given rise to discussions, which have turned out to the advantage of the profession; and it may be asserted, that at this day the treatment of the diseases resulting from poisoning by lead, is one of those things best understood; and without contradiction, that which is the most frequently followed by success. We shall proceed to consider separately, each of the poisonous substances of this class in their chemical relations, before examining their mode of action upon the animal economy, and the means of preventing or arresting their deleterious effects.

OF LEAD.

744. Lead is a solid metal; of a shining bluish white colour; it is soft enough to be scraped off with the nail, and to be bent in all directions: it is extremely malleable; its specific gravity is as 11,352.

745. When exposed to the action of caloric, it easily enters into fusion without becoming volatile, at least in any sensible manner.

746. Oxygen is capable of combining with lead, and of forming three oxydes, which differ from one another in their composition, and in their chemical and physical properties. The protoxyde is white, whilst it retains water; and be-

comes of a beautiful yellow when dried perfectly; the deutoxyde is red; the peroxyde is of a flea-colour.* All these oxydes when calcined with charcoal, in a red hot crucible, become decomposed in about twenty or five and twenty minutes, and furnish carbonic acid gas and metallic lead.

747. Lead exposed to the air, becomes tarnished, is oxydated and absorbs carbonic acid gas from the atmosphere, with which it forms carbonate of lead, which is soluble in an excess of carbonic acid.

748. Sulphur combined with this metal, furnishes a black sulphuret.

749. Water perfectly deprived of air, exerts no action upon lead, whilst aerated water oxydates it with the greatest facility. M. Luzuriaga has found, that it is sufficient to agitate lead in a little water, in contact with the air, in order to obtain a white crust of oxyde. This oxyde is scarcely formed, when it unites to the carbonic acid of the atmosphere, and gives birth to carbonate of lead, which is partly precipitated, and a portion of which remains in solution by favour of an excess of carbonic acid. M. M. Barruel and Merat obtained two ounces of acid carbonate of lead, extremely well crystallized, from six portions (*voies*) of water, left during two months in a pneumatic trough lined with lead.†

750. Nitric acid at the ordinary temperature converts lead into the proto-nitrate, and furnishes nitrous gas (deutoxyde of azote) which becomes of an orange colour in the air, by means of its combination with the oxyde of the atmosphere; from which we must conclude, that a portion of the nitric acid has been decomposed, in order to reduce the metal to the state of protoxyde. The salt obtained, crystallizes in

* M. Berzelius, in the Annales de Chimie, tom. lxxxvii. admits a fourth oxyde of a gray colour, less oxydated than the protoxyde we have mentioned.

† Traité de la Colique Métallique par F. V. Merat, 2nd edition, p. 93. Paris, 1812.

MEDICAL
CEYLON

tetraedral figures, the summits of which are broken off; it is of a white colour, fuses upon burning charcoal, and dissolves extremely well in distilled water, furnishing a fluid in which several re-agents produce precipitates remarkable for their colour (vide § 755).

751. Lead in its metallic state, is not poisonous, and may without inconvenience be associated with tin, with which composition kitchen utensils are tinned. M. Proust, in a very excellent work on this subject, has concluded, from a very great number of experiments:

"1st. That the tinning, which consists even of equal parts of lead, cannot be dangerous; since it is sufficient that the lead should be combined with tin, in order to prevent it from being dissolved, either in lemon juice, or vinegar, the two acids most to be dreaded. The tin, being more oxydable than the lead, dissolves exclusively in these acids, and prevents the second from being attacked. The lead cannot appropriate to itself an atom of oxygen, but the tin would carry it off in an instant.

"2nd. That lead, when combined with tin in equal proportions, and beyond that, can never take precedence of this last, so as to be oxydated, and dissolved before it. This same combination, internally taken, and in a much stronger dose than what a whole family could swallow, even when the whole of the tinning shall not last more than eight days, is not in a condition to expose even the slightest degree, the health of any one: neither is there a single example well attested of it."*

If instead of cooking acid aliments in vessels of tin alloyed with lead, vessels of this last metal only should be employed, there is no doubt but oxydation and solution of some of the metallic particles would take place, the ingestion of which

* Annales de Chimie, tom. lvii. p. 84. Mémoire de M. Proust.

would occasion symptoms, such as we shall describe in giving the history of the acetate and carbonate of lead.

OF THE ACETATE OF LEAD OF COMMERCE. *(SUGAR OF LEAD.)*

752. The acetate of lead crystallizes in *parallelopipedes* flattened, terminated by two surfaces disposed in *talus* or in unformed needles, of a white colour, and a sugary flavour, slightly styptic.

753. When exposed to the action of caloric in a crucible, it undergoes an aqueous fusion, then dries, and becomes decomposed, leaving a lump of metallic lead mixed with the yellow protoxyde, and an acid product of a fetid smell. This decomposition is similar to that which vegetable substances undergo when heated for some time (§ 511). The quantity of lead in the metallic state, thus obtained, will be more considerable if the acetate has been previously mixed with charcoal, and particularly, if it be submitted for a long time to the action of a strong heat.

754. The sulphuric acid of commerce, poured upon the acetate of lead in powder, decomposes it with effervescence, and sets at liberty vapours of acetic acid (vinegar) easily to be known by their smell.

755. The sugar of lead, treated by distilled water, is almost wholly dissolved at the ordinary temperature, provided at least that it be not mixed with a great quantity of the protoxyde, or other insoluble substances. The filtered solution is limpid, transparent, and colourless, and possesses very remarkable properties.

A. The sulphuric acid decomposes it, and gives rise to a precipitate of sulphate of lead, of a white colour, and very abundant: this phenomenon takes place even when the solution of acetate of lead is extremely diluted. The soluble sul-

phates of potash, soda, ammonia, &c. transform it also into an insoluble sulphate, and there remains in the fluid an acetate, the base of which varies according to the kind of sulphate that has been used. The sulphate of lead obtained by either of these methods, when dried, and calcined with potash and charcoal, yields its acid to the alkali; and the oxyde of lead, being set at liberty, quickly revives. We shall avail ourselves of this fact in the sequel.

B. Sulphurated hydrogen, whether gaseous or dissolved in water, and the soluble hydro-sulphurets, blacken immediately the solution of acetate of lead, and throw down a black sulphuret. (*Rationale* § 315.)

C. Sub-carbonate of soda poured into this salt, decomposes it instantly, and precipitates from it protoxyde of lead, combined with carbonic acid. This re-agent is much more sensible than the hydro-sulphurets for discovering the particles of lead dissolved in the acetic acid. The following experiment will put this fact beyond all doubt.

Two drops of the solution of acetate of lead, were diluted with six ounces of distilled water; the fluid was then divided into two portions, into one of which was poured the hydro-sulphuret of ammonia, or hydro-sulphurated water, which did not in the least change its transparency or colour, even at the end of four and twenty hours; into the other portion a few drops of a solution of sub-carbonate of soda were let fall; the liquor instantly became turbid, and threw down a white precipitate, which was completely collected together, twelve hours after the experiment. In order to be assured that this insoluble body was formed of the protoxyde of lead and carbonic acid, the supernatant fluid was decanted, and the precipitate washed with distilled water; to this a drop of nitric acid was added: all at once the solution was effected with effervescence, and the fluid obtained furnished a black precipitate with sulphurated hydrogen. M. Lambe had already observed this fact.

D. Spring water produces a white precipitate with the solution of acetate of lead; this phenomenon depends on the great portion of sulphates and carbonates, which is frequently met with in common water.

E. Ammonia separates from it instantly the white protoxyde of lead; the precipitate when washed and dried on a filter, acquires a yellowish tinge, in proportion as it loses the water with which it was combined; when calcined, it becomes of a beautiful yellow colour.' (§ 746.)

F. Chromic acid and chromate of potash instantly decompose the solution of acetate of lead, and convert it into an insoluble chromate of lead, of a beautiful canary-yellow colour.

G. Muriatic acid and the muriates produce a white grumous precipitate of muriate of lead, soluble in thirty or forty times its weight of distilled water.

H. Zinc brought in contact with the solution of acetate of lead, decomposes it, loses its brilliancy, and becomes suddenly covered with a black coat, upon which are soon perceived some small scales of lead extremely brilliant, and in such great numbers, that they end by filling the vessel almost completely. This phenomenon depends both upon the great affinity of the zinc for oxygen and for acetic acid, and upon the action which the electric fluid exerts upon the water of the solution. *Rationale* (vide § 317).

I. The infusion of galls in alcohol precipitates the solution of acetate of lead of a yellowish white; the same thing happens with a strong infusion of tea.

K. Burgundy wine also decomposes this solution by reason of the sulphates, carbonates, and muriates which it contains, and particularly the acidulous tartrate of potash and of lime, which enters into its composition, and which form with the protoxyde of lead an insoluble tartrate.

L. Albumine, poured into acetate of lead, produces a white precipitate in great abundance.

M. Pure gelatine does not disturb this solution.

N. Broth decomposes this salt, and separates from it white flakes, which exhibit the colour and consistence of glue, when dried upon a filter: if calcined in this state, they become decomposed in the manner of animal substances, grow yellow, and furnish in the course of an hour and a half, metallic lead.

O. Milk is coagulated by acetate of lead, employed in sufficient quantity. When one part only of this solution is mixed with fifty parts of milk, no disturbance is observed, and the hydro-sulphurets precipitate the mixture of a gray colour, bordering on black.

P. Human bile is copiously precipitated by the acetate of lead; the precipitate, which is composed of the protoxyde of lead and animal matter, is decomposed by heat, and furnishes metallic lead; nitric acid carries off this protoxyde and forms a soluble proto-nitrate of lead.

OF THE RED OXYDE OF LEAD, AND LITHARGE.

755. The deut-oxyde of lead (*minium*) is of a beautiful red colour, very heavy, and easy to distinguish from other preparations of this kind, by the following properties.

1st. When heated in a crucible, to above a brown red heat, it becomes decomposed, gives out oxygen gas, and passes to the state of yellow protoxyde.

2nd. When brought in contact with nitric acid diluted with its weight of water, it all at once changes colour, passes to a *flea-colour*, and after a few minutes' ebullition, is found to be completely decomposed, and converted into tritoxyde of lead of a *flea-colour* which remains at the bottom of the phial; and a soluble proto-nitrate of lead, which may be filtered; and in which the sulphuric, muriatic, and chromic acids, and the hydro-sulphurets, produce precipitates similar to those we have described in giving the history of acetate of lead. It may be conceived, that in this operation a portion of the

minium is decomposed, and brought back to the state of protoxyde, which combines with the nitric acid. The oxygen proceeding from this decomposition, acts upon the portion of *minium* not yet decomposed, and converts it into a flea-coloured tritoxyde.

3rd. Oxygenated muriatic gas (chlorine) introduced into water which holds *minium* in suspension, likewise reduces it to the state of flea-coloured oxyde, giving rise to protomuriate of lead.

757. *Litharge* is only the yellow protoxyde of lead melted, and which has been left to crystallize by cooling. It always contains a small quantity of carbonic acid, which it carries off from the air with which it is in contact. It is in the form of small reddish or yellowish scales, which are brilliant and vitrified.

758. Heated with charcoal in a red hot crucible, it becomes decomposed, and furnishes metallic lead and carbonic acid gas; this character likewise belongs to all the other oxydes of lead (§ 746).

759. When treated with nitric acid, it dissolves, without producing the flea-coloured tritoxyde, and the liquor contains proto-nitrate of lead.

760. When left for a month or two with Burgundy wine in the open air, it is observed to dissolve in part; the wine acquires a sugary flavour, and becomes of an extremely pale red colour, whilst the part of the litharge undissolved, passes to a dirty green. If the liquor is filtered and examined by the tests, it will be seen that it scarcely reddens the infusion of tournesol, which phenomenon is owing to the acetic acid formed by exposure to the air, being saturated by the litharge. The sulphuric and chromic acids, the chromate of potash, the hydro-sulphurets,* the sub-carbonate of soda, and zinc, pre-

* It sometimes happens however that the hydro-sulphurets are not to be depended on for discovering litharge dissolved in wine. In fact, almost all the red wines, without the addition of lead, produce a slight precipitate

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cipitate this liquor in the manner we have asserted, when speaking of the acetate of lead. Ammonia produces a dirty yellow turbidness, whilst the acetate of lead without mixture, yields a white precipitate to this alkali; from which circumstance we must conclude that no account is to be taken of this test in the examination of lithargyrated wines. Lastly; when this liquor is evaporated to dryness in a capsule of porcelain, and detached in order to be calcined in a crucible, in the space of an hour, metallic points will be obtained, consisting of lead, and surrounded by a great quantity of yellow protoxyde; the wine is found to be decomposed, and the charcoal proceeding from this decomposition, deoxydates a part of the protoxyde of lead. If it be wished to obtain all the metal from wines adulterated with litharge, it will be best to add charcoal to the mass, to be calcined in the crucible, in order that the decomposition of the oxyde may be more complete.

M. M. Merat and Barruel have proved, that a chopin of wine, left to digest in the cold for forty-eight hours, upon a drachm of litharge, dissolved twelve grains of it; so that whoever should drink only two bottles of wine, would take

of a dirty violet colour, when brought in contact with these hydro-sulphurets. This observation has been already made by M. Merat: "I am persuaded," says he, "that the hydro-sulphurets have been more than once the source of error, and have given rise to false reports in courts of justice; and it is a fact, that unless the comparative experiment be made, as we have done, that there would be no hesitation in attributing to lead the violet precipitate. which takes place even in wines not adulterated. This precipitate, and the violet colouring of the fluid, happen likewise to the wine that is the most pure and of the best growth, as I have repeated the experiment on Burgundy wine of the best quality." M. Merat rightly concludes, that hydro-sulphurated water ought to be preferred to the hydro-sulphurets, since it produces no change in genuine wine. This process is the true touch-stone for discovering the smallest quantity of lead which might exist in wine." (*Op. citat.* p. 114 and 115.) We have proved however that the sub-carbonate of soda is a more sensible re-agent than hydro-sulphurated water, since it discovers the oxyde of lead in a fluid which is not rendered turbid by the sulphurated hydrogen. (§ 755. *C.*)

forty-eight grains of litharge; and the *muid*, consisting of three hundred bottles, would not dissolve less than fifteen ounces.

OF THE CARBONATE OF LEAD.

761. The carbonate of lead is of a white colour, and dissolves readily in acido-carbonic water. If the fluid in which this salt is dissolved be evaporated, crystals of acid carbonate of lead will be obtained.

762. When heated in a crucible with charcoal, it becomes decomposed, and gives out metallic lead.

763. When weak nitric acid is poured on the carbonate of lead of commerce, it is decomposed; carbonic acid gas is disengaged, and the solution contains proto-nitrate of lead, which is easy to be ascertained by the re-agents mentioned § 755. If carbonate of lead be mixed with pure or carbonated lime, the liquor will contain likewise nitrate of lime. This mixture may be easily discovered, by pouring into the nitric solution a sufficient quantity of hydro-sulphuret of ammonia, in order to precipitate all the lead in the state of a black sulphuret (§ 755. *B.*); then the supernatant fluid, which consists of nitrate of lime and nitrate of ammonia, gives, on the addition of sub-carbonate of potash, a white precipitate of carbonate of lime, which may be washed and calcined, in order to procure the pure lime (§ 707).

OF WINES SWEETENED BY LEAD.

764. Wines sweetened by lead lose a great deal of their austere acid and bitter taste: they acquire a flavour which is sweet, and rather styptic.

765. When introduced into a glass retort, to which a balloon is adapted, they furnish, by the action of a gentle heat, alcohol, which condenses in the recipient, and there remains

in the retort, a thick fluid, consisting of the different fixed principles of the wine, and of the saturnine preparation which entered into its composition. *Rationale (vide* § 272). This character, added to those we have spoken of in giving the history of litharge, will not allow the confounding of wines adulterated with lead, with any other poisonous substance.

OF WATER IMPREGNATED WITH LEAD.

766. If we pay attention to the facility with which lead passes to the state of carbonate when brought in contact with aerated water, we shall not feel surprized that persons have sometimes been strongly incommoded by having drank water which had remained some time in reservoirs of this metal exposed to the air.

767. The hydro-sulphurets, sub-carbonate of soda, the chromic and sulphuric acids, &c. act with water impregnated with oxyde, or acid carbonate of lead, in the manner we have stated, when giving the history of this metallic acetate; but the existence of carbonate of lead in these fluids, can only be ascertained by the acids decomposing it with effervescence, and by its furnishing metallic lead when calcined with charcoal.

OF FOOD COOKED IN LEADEN UTENSILS.

768. Those kinds of food which contain free vegetable acids, or saline preparations, are capable of attacking utensils made of lead, of oxydating them, or of favouring their oxydation; and lastly, of dissolving them. We have already observed, § 751, and these consequences never follow when the lead is combined with tin, because this metal, being more eager for oxygen, prevents its solution. Whatever may be the state of the solution of lead mixed with the food, it communicates to it a taste more or less sugary, and metallic lead may

be obtained from it, by calcining it in a crucible. It is clear, that if the fluid part of the food contains lead in solution, the tests which we have recommended to be employed in § 755, will discover it, even when it only contains a few particles.

OF SYRUPS AND SPIRITS CLARIFIED WITH ACETATE OF LEAD.

769. M. Cadet de Gassicourt, in one article of the *Variétés Médicales*, speaks of the danger of applying to grocers, for clarified syrups of honey or raisins, as well as for brandy rendered colourless. This clarification being effected by means of acetate of lead, it is of the utmost importance not to leave any vestige of this dangerous salt in the fluid; and this is a precaution which these preparers, who are strangers to chemistry, cannot take. M. Boudet has likewise discovered the presence of a tolerable quantity of lead in these articles, blindly exposed to sale. (*Journal Général de Médecine, rédigé par M. Sedillot*, tom. xliv. page 321.)

The acetate of lead contained in these liquors will be easily detected by the tests we have recommended in giving the history of this salt, p. 448, vol. i.

ACTION OF THE DIFFERENT COMPOUNDS OF LEAD UPON THE ANIMAL ECONOMY.

770. A single glance at the medical observations hitherto collected, will be sufficient to convince any one of the danger to which those persons are exposed, who make use of lead and its compounds. Painters, plumbers, potters, glaziers, workers in glass, gilders, chemists, miners, &c. &c, are often attacked with the most severe colics, sometimes succeeded by death, from having only handled saturnine preparations, or even from being placed within the sphere of their emanations.

When injected into the veins, the salts of lead produce

symptoms exceedingly grievous, and destroy life in a very short space of time, even when only a few grains are injected. Lastly, when introduced into the stomach in no very large dose they universally give rise to symptoms, which are more or less severe, and which the animals sometimes sink under.

We conceive ourselves authorised to conclude, from a great number of facts ascertained with the greatest caution, that the phenomena exhibited by animals submitted to the action of lead, under the different circumstances we have just spoken of, take place from causes which are not always the same. We shall now relate the circumstances which appear the most proper to support this assertion.

CAUSES OF THE SYMPTOMS PRODUCED BY SATURNINE EMANATIONS.

1st. Animals living about the boilers, in which the preparations of lead are evaporating, in the course of a few days become dejected, lose their appetite, and pass their excrements with difficulty. This state of things in a short time grows worse; their urine soon becomes bloody; sometimes they vomit blood, and their excrements become tinged with it: their agony is expressed by a continual going round, in which action they expire, having the belly flattened laterally, and their flanks quite sunk in. One of these animals, after having remained some time in a warehouse of *minium*, died in horrible convulsions. Its limbs were strongly contracted, and the claws pushed out from the fingers; there was nothing remarkable in the interior, except a contraction somewhat distinct of the intestines: all the other organs were sound.

2nd. Edme V***, a potter, aged thirty-nine years, laboured under the metallic colic, and was treated for it in the *Charité*, in September, 1802. The month after, he was again seized; on the 24th of October, he was brought to the *Charité* about four in the afternoon: he was not able to utter a single word;

his wife informed us that he had been for several days seized with a very violent colic. The debility of this patient was so great that he died the same night about ten o'clock, without experiencing any convulsions.

Inspection of the Body. The body was robust, fat, full of flesh, and the tongue in excellent order: the thorax sounded well throughout; the abdomen was neither more retracted, or more tense than natural.

The brain was perfectly sound; its circumvolutions were entirely flattened, although not the smallest quantity of fluid was found in its ventricles. The heart was in its natural state, as well as the lungs, the right lobe of which adhered slightly to the posterior part of the *pleura costalis*. The liver was in good condition; as was likewise the spleen, except that it exhibited a cartilaginous concretion, forming a patch of about an inch broad on its convex surface. The stomach was sound, as well as the intestines, which contained no worms, but little gas, and scarcely any alimentary matter: the whole of the colon was shrunk in its diameter, but on introducing air into it, it resumed its bulk. The pectoral muscles were very red; the ribs were not fragile.

3d. Jean B***, house-painter, forty years of age, of a sanguine temperament, and strong constitution, was brought to the *Charité*, in the month of April, 1803. He was senseless; felt excruciating pains in the abdomen, which was contracted; the pulse was scarcely perceptible: the limbs were agitated with violent convulsions: he died a few hours after his admission.

Inspection of the Body. The tongue was clean, the belly tolerably distended, and not at all retracted; the muscles of the left arm were violently contracted.

The brain was sound, as were likewise the heart and lungs. On opening the abdomen, there exhaled a sharp and pungent odour; the liver was in its natural state, the spleen in good order, the stomach sound and empty; the small intestines

were sound, though rather red, and contained some gases; the colon and rectum were empty, and exceedingly contracted; but were easily distended; the cœcum contained yellow liquid fœcal matter; the kidneys and bladder were in their natural state, the muscles were extremely red.

M. Merat, from whom we have borrowed these facts, rightly concludes that lead, in these kinds of affections, exerts its deleterious influence upon the muscular coat of the intestinal canal, and particularly on the nervous system distributed over these muscles: thence the anomalous nervous appearances sometimes observed. "What tends to support my opinion, "that this disease is seated in the muscular coat, is the re- "traction and constriction of the intestine which exists in "certain parts of it; properties inherent in the muscles, not "possessed by the other systems. If the lead exerted its "action on the mucous coat, there would be a more abundant "secretion of the fluid peculiar to that membrane; there "would be either dysentery or diarrhœa, which is far from "being the case; since there is constipation. Still less does "this metal act upon the peritonæal portion of the intestines; "we should then have a kind of *peritonitis*, that is to say, "fever, tension of the belly, distension, heat, &c.—all which "phenomena are far from existing, and the direct contrary to "which are found; such as flattening of the abdomen, insen- "sibility to pressure, apyrexia, &c." *

CAUSES OF THE SYMPTOMS PRODUCED BY THE INJECTION OF SATURNINE PREPARATIONS INTO THE VEINS.

Experiment 1st. Thirteen grains of the acetate of lead of commerce, dissolved in a drachm and half of distilled water were injected into the jugular vein of a small and weak dog. The injection was hardly accomplished, when the animal made

* Merat, Op. Citat. p. 256.

three or four deep inspirations, and died without the least sign of pain or convulsions. He was instantly opened. The heart was beating forcibly; the blood contained in the left ventricle was fluid, and of a vermillion red colour; that which filled the right ventricle, was also fluid; the lungs, which were of a beautiful rose colour, were crepitating, and their substance did not appear to be hardened.

Experiment 2nd. Five grains of acetate of lead, dissolved in two drachms of distilled water, were injected into the jugular vein of a robust dog of middle size. The next day, the animal appeared to have ailed nothing. On the third day he became dejected, and refused to take food, and still preserved the power of walking. On the fourth day his movements became tortuous and difficult; his posterior extremities, which were weaker than the anterior, exhibited from time to time some very slight convulsive movements; he was extremely weak. He died on the fifth day at seven in the morning. The lungs were crepitating throughout their whole extent, and did not appear to shew the least trace of injury: the stomach was sound.

Experiment 3d. From one to three grains of acetate of lead, have been frequently injected into the jugular veins of several weak and middle-sized dogs, without their having appeared to be incommoded by it. Once or twice only the animals submitted to these experiments made some slight efforts to vomit, and threw up a small quantity of whitish stringy matter.

It follows from these facts, 1st. That the acetate of lead introduced into the torrent of the circulation, is not so energetic a poison as most of the other metallic salts; 2nd. That when it is injected in the dose of several grains, it is capable of producing serious accidents, followed by death more or less speedy, the cause of which appears to depend on lesion of the nervous system.*

* In one of my experiments on this salt, I obtained results which appear

CAUSES OF THE SYMPTOMS PRODUCED BY ACETATE OF LEAD INTRODUCED INTO THE STOMACH.

Experiment 1st. A small dog was made to swallow a drachm and a half of acetate of lead in a solid form. In five minutes, the animal vomited without effort a tolerable quantity of white matter mixed with food. These vomitings were repeated four times in the course of the first half hour after the ingestion of the poison: and it was only after making the most violent efforts, that he succeeded in throwing up, the last time, some yellow stringy matter of a bilious appearance. The next day, he took food, and did not appear at all ill. Considering him to be recovered, ten days after the first attempt at poisoning, he was made to swallow, fasting, *three drachms and a half* of the same salt reduced to a fine powder. Shortly after, he vomited up some white, stringy, and frothy matter, and had two yellowish stools, in which he passed some solid excrements. During the first fifty minutes, he did not cease to make the most violent efforts to vomit; and it was with the utmost difficulty that he succeeded in throwing up

to me important to be made known. After having injected into the jugular vein of a dog of middle size, ten grains of acetate of lead dissolved in two drachms of distilled water, the animal appeared suffocated; his respiration became difficult, panting, and precipitate: there flowed from his mouth, a tolerable quantity of reddish serosity; and he died thirty-five minutes after the injection, without having given the least sign of vertigo, paralysis, or convulsions. On dissecting the body immediately after death, the lungs were found livid in patches, their texture more tight than in the natural state, and very little crepitating. The heart scarcely contracted; it was found empty. The other organs exhibited no signs of injury.

Is this isolated fact sufficient to prove that the acetate of lead acts upon the lungs? I think it is allowable to doubt it. In fact, if this compound exerted its action on these organs, should we not have found in experiment the 1st, the blood of the left ventricle blackened? and in experiment the 2nd, would not the animal, after having experienced the action of the poison during four days, have exhibited some sort of injury of the lungs?

thrice a small quantity of white and mucous foam; he had then another stool, and fell into a state of dejection. Six hours after the poisoning he appeared cast down, was little sensible to external impressions, and remained lying on the belly. He died the next day at five in the evening, twenty-eight hours after swallowing the poison, without having been agitated by any convulsive movements, or uttering the smallest complaint.

The mucous membrane of the stomach was red in patches, evidently inflamed, and covered with a small quantity of a flaky fluid; the muscular coat underneath presented a clear red colour. The other parts of the digestive canal exhibited no remarkable alteration; the diameter of the large intestines did not at all appear contracted; the lungs were in their natural state.*

Experiment 2nd. At one o'clock, the œsophagus of a small dog was detached and perforated; an ounce and a half of acetate of lead, dissolved in three ounces of distilled water, was then introduced into the stomach, and the œsophagus tied below the opening, to prevent vomiting. At the end of six minutes, the animal began to make the most violent efforts to vomit, and repeated them frequently during the first half hour after the operation. At forty minutes past one, he had a liquid stool, in which was a small quantity of solid excrement. At four o'clock he was lying on his side, and had a convulsive trembling of the muscles of the right fore leg: his limbs were from time to time agitated by slight movements; when set up on his feet, and dragged on by means of a cord, he made a few steps with very great difficulty; shortly after, his posterior extremities bent down; the animal remained for a few moments as if he had been drunk with wine, then fell all at once upon his head, like an inert mass abandoned to its own weight;

* On analyzing the matter thrown up in the first vomitings, it was easy to ascertain that it contained a very great quantity of the acetate of lead which the animal had swallowed.

he continued to make fruitless efforts to vomit. At six o'clock these symptoms had acquired greater violence; he was almost dying. He expired at half past ten at night.

Dissection. On opening the abdomen, we were struck with the beautiful white colour of the portion of the digestive canal contained in this cavity, which exhibited nevertheless here and there some reddish streaks. The stomach contained a tolerable quantity of fluid; on letting it out, there was perceived in the interior of this viscus, a lining like a membrane, of a clear blue colour, similar to that of ashes, which could easily be removed by scraping it lightly with a knife.

This lining, which was about one line in thickness, had a grumous appearance, and possessed the same taste as the acetate of lead; it diffused a smell somewhat resembling that of *vinegar of the four thieves.* The mucous membrane throughout its whole extent, and on every point of the stomach, exhibited a gray ash-colour: the two other coats of this viscus did not appear to have suffered any sensible alteration: on the whole internal surface of the intestines, a grayish and grumous lining was also observed, similar to that in the stomach: the diameter of the great intestines was not in the least contracted. The lungs, which were crepitating in some points, presented patches of a livid red substance, more compact than in the natural state.

Experiment 3d. At eleven o'clock, a dog of middle size was made to swallow while fasting, an ounce and a half of acetate of lead solid and perfectly levigated: five minutes afterwards the animal made efforts to vomit, and threw up at three different times a tolerably great quantity of whitish matter: these vomitings returned again in the course of an hour. At four o'clock he was quiet, and appeared to be suffering pain in the belly. The next day at nine in the morning, he drank a great quantity of water, which he soon threw up, and refused to take food: he enjoyed the free exercise of his limbs and his senses: and was not agitated by any convulsive

movements; he expired at six in the evening, in a state of great dejection.

The *Dissection* took place the next day at noon. On opening the stomach, the mucous membrane was found to be of a deep red colour throughout its whole extent: near the cardia were found several spots of a black colour, about the size of a pea; the portion bordering on the pylorus, likewise exhibited a few of these spots; it was moreover sprinkled with a multitude of points of small diameter, and of a blackish gray colour: the surface of this membrane, which is in immediate contact with the muscular coat, as well as the muscular and serous coats, were of a fiery red colour, so that the stomach appeared to be highly inflamed, even before it was opened. The intestinal canal presented no alteration; the lungs were perfectly sound.

It results from these facts: 1st. That acetate of lead introduced into the stomach in a large dose, produces death in the course of a few hours, even when the animals are allowed the power to vomit. 2nd. That animals who swallow this salt in a solid form, and throw up a part of it by vomiting, die in consequence of the corrosion it produces in the digestive canal; which corrosion the inspection of the dead bodies places beyond all doubt. 3d. That when taken in a liquid form, and it lies long enough in the stomach for absorption to take place, its fatal effects depend more on its action upon the nervous system, than on the inflammation it produces. 4th. That it produces no serious symptoms unless when taken in a sufficiently strong dose, and after having remained a sufficient length of time in the stomach. When swallowed in small quantity its action is confined to the exciting vomiting, and increasing the alvine discharges: the same thing takes place in a great number of saturnine preparations.

We think proper to support this last conclusion by a few fresh experiments.

1st. A small dog was made to swallow an ounce of acetate

of lead, dissolved in three ounces of distilled water: he instantly vomited a very considerable quantity of fluid matter, in which was a great deal of acetate of lead, and some alimentary matter: these vomitings were six times repeated in the space of fifteen minutes. The next day, the animal was tormented with an ardent thirst; he drank a great quantity of fluid, which was quickly vomited; he did not appear to be ill. At two o'clock he ate a little meat, which he likewise threw up a few minutes after; his movements were perfectly free. On the third day he refused food; he continued to be tormented by an ardent thirst, and no longer vomited the drink which he took. On the sixth day, he began to take nourishment. Nine days after the introduction of the poison, the animal, who possessed a great degree of activity, attempted to escape, making frightful howlings: he was consequently muzzled in a very strong manner, and by that means was choaked.

The membranes of the stomach and intestines were sound, and did not in any manner exhibit the appearance we have spoken of in the dissections of those dogs which form the subjects of the preceding experiments.

2nd. Half an ounce of *minium* (red deutoxyde of lead) was given to a small dog. At the end of three quarters of an hour, the animal vomited some red matter, and did not appear to suffer any pain. The next day he refused to eat. On the third day he was made to take six drachms of the same oxyde; an hour and half after, he vomited almost the whole of the poison taken. The fourth and fifth days he refused food; he drank a tolerable quantity of water, and appeared rather dejected. On the sixth day he began to eat. The seventh and eighth day he had an excellent appetite, and a great deal of food. He made his escape on the tenth day, and it was impossible to catch him.

3d. A dog of middle size was made to swallow half an ounce of carbonate of lead: he vomited four times in the

space of ten or twelve minutes. The next day he fed as usual, and appeared perfectly recovered.

SYMPTOMS OF POISONING BY SATURNINE PREPARATIONS.

OBSERVATION 1st.

Germain R***, manufacturer of earthen ware, aged thirty-three years, of a good constitution, was attacked suddenly, on the 27th of January, 1804, with very severe abdominal pains, seated principally about the navel, accompanied with hardness and retraction about the belly. The same day he lost his appetite, and had no stools; the colics continued all night, and prevented him from sleeping. The three following days the same phenomena continued, notwithstanding the use of milk and emollient glysters which the patient took. On the fourth day he came to the *Charité*: the pains were acute, without remission, and occupied particularly the umbilical region; the belly was neither very hard, nor sensibly retracted; there existed loss of appetite and constipation; the pulse was nearly natural.

The *treatment* was immediately entered upon (*vide* the treatment of the *Charité* immediately after § 781.) The first medicines were vomited without any mixture of bile; the glysters produced copious stools of hardened excrement; and from the first evening of his entrance, the patient declared that the colics had lost three-fourths of their violence. He slept during the night. The vomit of the next day procured considerable evacuations upwards and downwards; the matter vomited was yellow and bitter. The cathartics had produced copious and liquid stools; the succeeding days, the gripes disappeared, sleep and appetite returned; and on the fifth day from his admission, the patient went out of the hospital perfectly cured.

OBSERVATION 2nd.

D***, a plumber, aged forty years, of a bilious temperament, and pale countenance, had already laboured under the painter's colic four times. This attack, which was the fifth, had already existed four days. He was admitted into the *Charité* in the month of January, 1803, when he was in the following condition: belly supple, but painful, particularly about the epigastrium; pain increased on pressure; no stools except by the glysters; pulse rather slow; paralysis of the *extensores* muscles of the hands, which had existed two years, but was become much more notorious within these few days. On the 14th commenced the treatment *(water of cassia fistularis, with three grains of emetic tartar, sudorific ptisan, anodyne glyster, theriaca, two plates of soup, three of broth).* The 15th, *(six grains of tartar emetic in eight ounces of water, sudorific ptisan, anodyne glyster, theriaca with a grain of opium, two plates of soup, three of broth).** Gripes very severe; had four or five attacks in the day, is seized by convulsions, called cramps, with loss of sense for about half an hour, or an hour, without the least foaming at the mouth. The 16th *(Infusion of tilia, antispasmodic draught, five plates of soup),* fresh attack in the morning. During the day agitations and movements of the arms, pulse very small and frequent, pain of the belly. In the evening, sharp pains in the abdomen, in the neighbourhood of the kidneys, and in the thighs; agitation; pulse small, unequal, and frequent; looks wild. The 17th *(same prescription),* appearance more tranquil, pains slight in the belly, sharp in the thighs; agitation; pulse tense, concentrated, and frequent. The 18th *(idem),* looks still wild, delirious at intervals, in other respects the symptoms are the same as on the 16th. The 19th, delirious in the night. The 20th, the same state. The 21st, less de-

* The terms *soup* and *broth*, almost synonymous in our own language, in French are very distinct: *soup* is formed from vegetables and slices of bread, *broth* always from meat.—*Translator.*

lirium, scarcely out of his senses. The 22d, the same state. The 23d, *(up to this day the same prescription as the* 16th), the patient has recovered his senses. On the following days he was restored to his ordinary state of health before his admission into the hospital, that is to say, he went out cured of his colic, but not altogether of the paralysis. He went out on the 3d of January.

OBSERVATION 3d.

Jean C***, aged twenty-eight years, a plumber, of a bilious sanguine temperament, had enjoyed good health till he was twenty years of age, at which time he began his business. From that time, till the month of October, 1803, he was four times attacked with the metallic colic, which was accompanied each time with vomitings of yellow and fetid matter, frightful and repeated convulsions, and sharp pains in the epigastrium. The last colic, which happened three years before this one, lasted three months; but, like the others, yielded to the treatment of the *Charitē*.

In the month of October, above-mentioned, the fifth attack was distinguished by loss of appetite, spontaneous vomitings, general uneasiness, pains in the limbs, a general sensation of cold which was not followed by heat, and constipation. The next day the patient was in the same state; he experienced beside violent gripings, considerable convulsions, which returned seven or eight times in the day, with contraction of the jaws, convulsive movements of the eyes and of all the limbs, with such agitation and struggling, that several men could scarcely hold him; the urine was free. During the eight following days, the state of the patient was equally distressing; the convulsions returned from time to time, and were constantly followed by deep sleep, and on waking, by pains in the limbs and in the epigastric region. On the tenth day of the disease he was brought to the *Charité*. He had passed the night in violent delirium; his eyes were puffed up, and painful all

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round them; his countenance was rather animated, his aspect expressed astonishment, his mouth was clogged, the tongue natural, respiration free; the abdomen and loins were rather tumefied, and painful to the touch; the heat of skin natural, and the pulse rather elevated and frequent. During the night the patient had severe pains, convulsions, delirium, and copious stools.

Notwithstanding these anomalous symptoms, the relation of the patient, the recollection of former diseases which had commenced in the same manner, and had yielded to the treatment for colic, many of the characters of the existing disease removed all hesitation about employing the same treatment. In that same day the colic became less, but the navel continued very painful: several stools and vomitings succeeded. On the twelfth day, there was scarcely any more colic, and not any delirium. On the thirteenth, a complete cessation of the pains; and on the sixteenth day, the patient went out of the hospital.*

OBSERVATION 4th.

N***, aged twenty-five years, of a bilious temperament, who had been employed as a colour-grinder for eighteen months past, had experienced the metallic colic for the first time about seven months before. On the 5th of July, 1805, he again felt the first symptoms of a second attack. At first, slight colics, loss of appetite and of sleep; borborygmi; in a short time pains of the abdomen more severe, with vomitings; he felt also painful lassitude in the arms; this was felt still more in the night. The two following days the symptoms went on increasing; he came to the Clinical Ward.

On the 8th, the belly was contracted, the pulse hard and slow; pressure on the abdomen gave him very little relief; but on pressing the epigastrium, the pulsation of the cœliac ar-

* Observation communicated by M. Laennec, M. D.

tery was felt. *(Water of cassia with three grains of tartar emetic, purgative glyster, simple sudorific ptisan.)* The patient threw up the cassia-water, mixed with green and viscid flakes, and hard no stool. The glyster caused the passage of some hard excrement in small balls, and afterwards of some liquid stools, which gave him relief.

The 9th. *(Six grains of stibiated tartar dissolved in eight ounces of water, simple sudorific ptisan, anodyne glyster, theriaca, with a grain of opium).* Copious vomitings of greenish matter, no stools; pains of the belly were severe.

The 10th. *(Simple sudorific ptisan, laxative sudorific ptisan, purgative and anodyne glyster, theriaca with a grain of opium).* In the morning he experienced most painful gripings; four or five liquid stools during the day, three during the night; he continued to complain, but the gripings were less severe.

The 11th. *(Painter's purgative prepared with senna, Glauber's salts, powder of jalap, and syrup of buckthorn; simple sudorific ptisan, anodyne glyster, theriaca with one grain of opium).* He has been several times to stool, and finds himself greatly relieved; he slept during the night. Towards morning he felt some painful inclinations to go to stool, and pains in the knees and loins. Appetite returned.

The 12th. *(Laxative sudorific ptisan, simple sudorific ptisan, purgative and anodyne glyster, theriaca with a grain of opium).* He experienced no more griping, went several times to stool, and slept well in the night.

The 13th. *(Painter's purgative, simple sudorific ptisan, anodyne glsyter, theriaca with one grain of opium).* He had four stools, and the gripings have altogether ceased.

The 14th. Sixth day of the disease. *(Laxative sudorific ptisan, simple sudorific ptisan, purgative and anodyne glysters, theriaca with a grain of opium).* He went out the next day perfectly cured.

OBSERVATION 5th.

Victor D***, twenty-four years of age, a painter since he was thirteen, of a slender habit of body, had always enjoyed a good state of health. Eight years ago he had been subject to head-aches *(migraines)*, and vomited every eighth day. For three years past he had been afflicted with colics, and had felt no more head-ache. The first of these lasted two or three days, and left after it an interval sometimes of one or two months. For the last year and a half, he suffered more of them, and they were almost continual; they were less severe in the morning, stronger in the evening, and still more so at night. After eating, and being attacked by the colic, in a few hours he vomited. He was habitually costive, and only went to stool once in two or three days; his excrements resembled those of sheep. His appetite was rather feeble; he slept very little: in other respects he felt no pain. For a month past he had ceased from all work, although not confined to his bed. He had made use of anti-spasmodics and opium, as well as of the mineral water of *Guindre*, without receiving from this last much relief. On the 15th of April, 1803, he was received into the *Charité* in the following condition: no bitter taste in the mouth, tongue clean; the belly sunk in at certain points, and projecting at others; the muscles of the abdomen clearly delineated through the integuments; pressure slightly painful towards the umbilicus, and not so at the epigastrium; sonorous borborygmi; constipation; pulse slow, and a little irregular; urine free; gets some sleep towards morning. On the 16th the treatment of the *Charité (vide* immediately after § 781) was begun, and continued on the following days: no vomiting, one stool. The 17th. The day has been passed quietly: some gripings towards evening; one stool. The 18th. He had much griping, with a kind of convulsions of the muscles of the belly; vomited once, and had two stools. The 29th. Borborygmi, griping less, two stools, very little appetite.

The 30th. Little or no colic, two stools; has slept tolerably well; has rather a bitter taste in the mouth. The 1st of May. Considerable gripings, lumps rising up in the belly. The 2nd. One stool: colic tolerably severe at eleven o'clock in the morning; appetite begins to return. The 3d. Ten stools without griping; he feels scarcely any more pain; the belly restored to its natural state: is thirsty in the night. The 4th. Some griping in the course of the day; five stools: the patient was also griped during the night. The 5th. Colic very slight. The 6th. A great many stools; no longer any griping. The following days, perfect convalescence. He went out on the 9th, perfectly cured.

OBSERVATION 6th.

D***, house-painter, aged thirty-six years, of a good constitution, experienced in the month of November, 1809, slight colics, which occupied the whole belly: his appetite was lost; he continued however to work; but the colics increased, notwithstanding he took milk to appease them. Some theriaca however which he took in brandy procured him a little relief. He came to the *Charité* for cure, sixteen days after the invasion of the disease. There was no head-ache, the tongue was dry and white, he had a disagreeable and bitter taste in the mouth; his breathing was free; he felt severe pains in the belly, which were not increased by pressure, although the patient seemed afraid of it. He had had no alvine evacuations for three days; the urine was scanty: the pulse slow, giving only forty pulsations in a minute: the patient had not slept for three days.

The treatment was immediately entered upon. He went twice to stool, passed a great deal of urine; the pains and the pulse were in the same state. The vomit administered to him on the second day of his admission, made him throw up eight different times a greenish matter: he slept at night: the pains became less, and the pulse natural. The purgatives

evacuated him freely the following days; and on the twelfth day from his admission he went out of the hospital perfectly cured. (These observations are extracted from the dissertation of M. Merat.)

To these different facts, we think proper to add the following:

1st. James, in his Medical Dictionary, tom. ii. p. 837, says, under the article *Bellon** that he has twice been obliged to treat persons labouring under this colic for having taken *Sugar of Lead* (acetate of lead) for the purpose of stopping the *fluor albus*.

2nd. Tissot reports, that the acetate of lead, administered in Phthisis Pulmonalis, has three times occasioned the metallic colic of which we are treating.

3. M. Bourdelin, Professor of Chemistry in the King's garden, discovered that the greatest part of the colics under which the inhabitants of the Faubourg St. Germain laboured, were saturnine colics, produced by wine in which litharge had been dissolved.

4th. Vantroostwyk, in his work on Medical Electricity, says that some waters containing lead in solution, caused the same disease in Haarlem.

A whole family, according to the report of Van Swieten, were attacked by paralysis, for having for a long time made use of water contained in a large vessel of lead. Another family experienced the same disease, for having drank the water of a well, loaded with *selenite*, and which had attacked the lead of which the vessel was composed that served for drawing the water. The father of this family was for a long time attacked with palsy; the mother died in consequence of a long and painful colic, accompanied with icterus: out of twenty-one children, eight died in infancy, and the others were ill every

* A name by which the colic of lead, according to this author, is known in England.

time they came to live in their father's house. There are likewise instances of unfortunate accidents occasioned by water transmitted through leaden pipes, or by rain water falling off the roofs of buildings covered with lead, and received afterwards into vessels.*

5th. M. Verdelhan, formerly Physician of the *Charité*, speaks of a glazier's wife, who had experienced very painful colics, and acute pains of the matrix, from having made use of a chafing dish, which contained lighted charcoal, mixed with scoria of lead.

6th. Lastly, Wedekind, Boerhaave, De Brambila, Haeberl, Percival, Wall, &c. &c. speak of colics of this kind produced by the external application of plasters or cataplasms, into the composition of which lead had entered.†

771. After having established the facts which are to serve for the medical history of poisoning by lead, we shall proceed to trace out the symptoms which characterize the colic proceeding from emanations of this metal, from the moment of its invasion to its termination.

Invasion. This is sometimes rapid enough, at other times slow: in the first case, the patient perceives gripings more or less severe, which at first are of short duration, but return immediately, and at last are continued. The excretion of the alvine discharge is painful and difficult: the excrements are hard, and like those of some animals; the patient experiences nausea and vomiting, particularly when the pains are most acute. The abdomen retracts, and sinks in towards the navel; and those parts which form the anterior parietes, tend towards a contact with the vertebral column: anorexia and watchful-

* Wall, in Medical Treatise, Plenck, Toxicologia, p. 250, anno 1784.

† We shall confine ourselves to the pointing out those cases of poisoning by saturnine preparations introduced into the stomach, or externally applied; the symptoms which accompanied them bore the greatest resemblance to those we have detailed in the six observations of metallic colic produced by the emanations of lead.

ness come on. The degree of anxiety is sometimes very great, and the patients are obliged to take to their bed. It is worthy of observation, that fever does not take place, whatever be the intensity of the pains.

In some persons, it has been seen, that the symptoms we have been describing have appeared all at once with great energy: this sudden invasion is very uncommon.

In the slow attack, the gripings begin by being obtuse, and very soon cease; they then return again in a short time, and produce pains which in the end become insupportable. The other symptoms we have been describing, soon make their appearance.

Beside these symptoms, there are others which belong to the two varieties of attack. The countenance is pale, or rather yellowish, and sharp during the pain: by placing the hand on the belly, far from increasing the pain you relieve it. There is scarcely ever any head-ach; the breathing is sometimes difficult: sometimes also the limbs are in great pain, which is more violent at night. Very frequently there are eructations—borborygmi are rarely observed. Delirium, icterus, retraction of the testicles, convulsions, &c., are so many accidental symptoms which sometimes accompany this complaint.*

772. We are of opinion that it would be useful to dwell upon some of the principal phenomena of this kind of poisoning.

Eructations. I have twice observed, in persons attacked with the painter's colic, excessively frequent eructations, which produced in the mouths of the patients according to their own

* Plenck in his *Toxicologia*, points out several other symptoms; such as dryness of the mouth, a sense of strangulation, vertigo, cough, dry asthma, hic-cough, slow inflammation of the viscera of the abdomen, ischuria, dysuria, aphonia, cold sweats, and death. According to this author these symptoms principally make their appearance, when some saturnine preparation has been introduced into the stomach.

account the same sensation as any thing sugared. This circumstance is extremely rare; I do not know that any author has taken notice of it.

The Vomitings. Their duration is variable: sometimes they continue for several days; but for the most part they cease after the second day of the treatment. The matter of which they consist, is liquid, greenish, or blackish, and bitter.

Retraction of the Abdomen. M. Merat, in order to give an idea of this remarkable symptom, says: "The retraction of the abdomen is a phenomenon purely mechanical. Suppose an elastic cord extended from the pubis to the xiphoid cartilage; if it be pressed from within outwards, it will become convex: on the contrary, suppose that nothing presses upon it, it will then resume its natural state, that is to say, it will form a line exactly straight. The intestines in their natural state, push the covering of the anterior muscles of the abdomen forwards, and form the projection we observe: if they are drawn in, contracted, as in the metallic colic, the muscular parietes form the straight line, if the retreat of the intestines be not beyond this line; for if they be still more retracted, the abdominal parietes follow them, probably from the effect of atmospherical pressure; and then these parietes, especially the umbilical region, which is naturally rather convex, are excavated beyond the right line, or supposed to be in that state: this is what is called *the belly depressed inwards,* or simply *retracted.* As the contraction of the intestines is stronger in proportion as the pains are more violent, it will follow, that the more intense the colic is, the more the belly will be retracted; and consequently we may judge of the intensity of the colic by the retraction of the belly." (*Op. Citat.*)

Pressure. When the umbilical region of a person attacked with metallic colic is gradually pressed with the hand, the pain diminishes, and the patients experience so much relief,

that they do not hesitate under certain circumstances, to make two or three persons get upon their belly.* However, it sometimes happens that the pain is increased by the slightest pressure; so that this sign cannot be considered as pathognomic of this affection.

The Gripes. According to M. Merat, the continued pains, which persons attacked with this disease experience, are seated in the small intestines; whilst those which are more acute, and which come on by fits, have their seat in the colon, principally in its transverse portion. We shall not attempt to explain the cause of the pain which accompanies these colics; we are afraid of being bewildered in conjectures.

Constipation is a symptom common enough in this affection; it appears to depend on the progressive constriction of the intestinal canal, which opposes the excretion of the accumulated matter. Sometimes the patients, far from being constipated, are tormented with a looseness more or less considerable.

The absence of Fever. It is easy to prove, that the colic of Lead is rarely attended with fever: out of fifty-seven patients observed by M. Merat, in the year 1811, three only had fever: I can affirm that I have seen, in my own practice, a very considerable number of cases of this kind, without having ever once met with a patient in a febrile state, at least unless there was complication.

The urine presents no particular character.

The alvine excretions are generally of a yellow colour, they are rounded and hard, like the excrements of a quadruped: in proportion as the disease advances, they soften and become almost watery.

* Fernel. de Lue Venerea, cap. ii. Merat, p. 51.

LESIONS OF TEXTURE PRODUCED BY THE PREPARATIONS OF LEAD.

773. We have proved, that acetate of lead introduced into the stomach in the dose of several drachms produces inflammation of one or more parts of that viscus: at one time the mucous membrane of the stomach is simply attacked with phlogosis on its inner surface; at another time the inflammation extends to that surface, which is united to the muscular coat; in this case it is often of a very deep red colour, and the other membranes of the stomach partake more or less of the inflammation. There are sometimes observed, in the interior of this organ, black points, or spots, varying in size and extent; which are almost always the consequence of a certain quantity of extravasated venous blood, or of the injection of the blood-vessels by the same. Lastly, we have seen in the stomach of animals who have taken a strong dose of acetate of lead, and have not vomited, a membranous lining tolerably thick, of an ash colour, easily detaching in small pieces; the origin of which appeared to be owing to the decomposition of a part of the acetate of lead by the mucous, bilious, and other fluids, contained in this viscus. The mucous membrane lying under this lining, was of a dark gray colour throughout its whole thickness, and appeared to have exercised the same action on the acetate of lead. The same phenomenon had taken place along the whole course of the intestinal canal. It is easy to conceive that the other preparations of lead would produce similar lesions when taken in sufficient quantity to occasion death.

774. The case is not the same with saturnine emanations. All writers on the subject agree in declaring, that in the colics produced by them, the digestive canal exhibits no vestige of inflammation; a contraction of the diameter of the great intestines, particularly of the colon, is the only thing

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observed. The dissections which we have detailed in pages 458, &c., leave no doubt on this subject. The metallic particles emanating from these kinds of substances act directly on the nervous system, without a possibility of demonstrating their presence in the intestinal canal, as we shall soon prove.

M. Fodéré adds, that the bodies of persons who have died of the colic of lead, exhibit the mesentery and its glands, the chyliferous and lymphatic vessels, inflamed and obstructed, and the thoracic duct nearly obliterated. According to that author, the liver, spleen, pancreas, and lungs, are often inflamed, tumefied and purulent, and the heart shrivelled. The whole body, in consequence of the constriction of the chyliferous vessels, is in a state of complete marasmus. We are under the necessity of declaring, that almost all these signs are wanting in the majority of the cases of simple colic of lead, terminated by death. (Vide Merat, p. 213 et seq.) We have not observed one of these appearances in the two persons we have seen die of this affection.

Henckel has asserted, without ever having opened the body of any person who had died of the painter's colic, that this disease induced inflammation and gangrene of the intestines. Bordeu asserts that he has seen the intestines abraded, livid, swelled, bruised, perforated, &c.; but an attentive examination of the facts related by this author, will make it evident, that the lead colic, in all the persons of which he speaks, was complicated with peripneumonia, peritonitis, &c. (*Journal de Médecine*, tom. xxvi. p. 210.)

APPLICATION OF ALL THAT HAS BEEN SAID TO THE DIFFERENT CASES OF POISONING BY SATURNINE PREPARATIONS.

FIRST CASE.

The Person is living: the rest of the Poison can be procured.

775. *A.* Whatever may be the preparation of lead, the introduction of which into the stomach has produced the symptoms, it can be easily ascertained, if it be without mixture, 1st, by the facility with which the metal can be obtained from it, by calcining it in a crucible with charcoal; 2nd, by the action exerted upon it by the sulphuric, chromic, and muriatic acids, the alkalies, the hydro-sulphurets, and the sub-carbonate of soda. (Vide § 752—760.)

B. For a great length of time, the wine-merchants have added litharge to sour wines, with the intention of sweetening them. According to M. Moller, the inventor of this fraud is a priest of the Black Forest. This adulteration may be ascertained, 1st, by distilling a part of the fluid in a retort, in order to obtain the alcohol; 2nd, by calcining the residuum with charcoal, in order to separate the metallic lead; 3rd, by assaying another portion of the adulterated wine, by the reagents we have described. In these trials, the juridical physician will pay no attention to those precipitates, whose colours exhibit anomalies dependant upon the action of the wine: such are those obtained with ammonia, and sometimes with the hydro-sulphurets (§ 760).

Percival (*On the Poison of Lead*, p. 61) relates, that accidents have happened in the sugar-refining houses at Manchester, from the drinking of beer, which had been fermented in vessels of lead. It is clear, that in this case the metal had been oxydated and dissolved: it may therefore be found again,

by submitting this spirituous liquor to the proofs we have pointed out for wine.*

C. The bakers have sometimes employed cerusse (*white lead*) for the purpose of rendering the bread heavier or whiter. The presence of that variety of the carbonate of lead may be ascertained, 1st, by calcining the flour or the bread in a crucible, in order to convert the vegeto-animal parts into charcoal, which will not be long in reviving the metal; 2nd, by treating another portion by the acetic acid at the ordinary temperature, and pouring upon the acetate of lead formed, the re-agents proper for recognizing it (§ 755). The same operation may be performed upon bread made of leaven, which has been some time in leaden utensils.

D. Evaporation and calcination may likewise be employed to separate the lead from oils that have been clarified with the

* I think it will be useful to make a slight digression on adulterated wines: it has been suggested to me, by reading the work of Rozier on Agriculture. This philosopher (tom. i. p. 441) affirms, that the wine-merchants of Paris put into a cask of wine of five hundred bottles, as much as a pound of alum. (*Acid sulphate of alumine and potash, or acid sulphate of alumine and ammonia.*)

I gave to a dog six drachms of alum in powder; an hour after, the animal vomited without effort, and did not appear very much incommoded. The next day he ate as usual, and was perfectly recovered. This experiment would create a belief that alum mixed with wine, might under certain circumstances, occasion accidents. This salt may be known by the following characters: 1st. It is soluble in water, and the solution, which possesses an astringent taste, reddens the tincture of tournesol. 2nd. Ammonia decomposes it, and separates all the alumine: potash produces the same effect, but the precipitated alumine re-dissolves in an excess of alkali. 3d. Muriate of barytes precipitates from it sulphate of barytes, which is insoluble in water, and in nitric acid. 4th. The sub-carbonates of potash and soda, separate from it immediately, gelatinous flakes of a white colour. 5th. Lastly, pulverized alum disengages no gas, nor becomes decomposed on the addition of concentrated sulphuric acid. If by its union with the wine, the precipitates obtained should be more or less coloured red or violet, we might, before making the trials pointed out, discharge the colour from the mixture, by boiling it with fresh charcoal of the tilia (*lime* or *linden tree*) finely pulverized.

oxyde of this metal, for the purpose of sweetening them, and absorbing altogether their disagreeable smell. The same process will serve for a multitude of other mixtures similar to those we have just spoken of.

E. If the poisoning has been occasioned by saturnine emanations, it can only be known by the existing symptoms, and the history of the case. It will be in vain, in cases of colic produced by metallic effluvia, to have recourse to experiments made on the excrements and urine: analysis proves that it is impossible, in these substances, to discover the lead. M. M. Barruel and Merat, examined the urine of a person affected with this disease: it was not at all disturbed by the addition of the hydro-sulphuret of ammonia, and the part which subsided did not exhibit the least vestige of lead. On comparing the results which it furnished with those given by the urine of a healthy person, they saw that there was not the slightest difference. M. Merat observed, that the excretion of the urine in this patient was extremely painful; which would induce a belief, that the morbific cause was more active than in the case where it flows naturally, and that it appeared to act more particularly upon the bladder.

The excrements have likewise been the objects of research by M. M. Barruel and Merat. They reduced to charcoal, six pounds of the excrements passed during the first eight days of the metallic colic, a period when the third purgative had already produced its effect, and when the patient experienced no more pain. The charcoal when burnt, furnished forty-four grains of ashes: four ounces of distilled water poured upon them, furnished a fluid, clear, transparent, devoid of smell, and of a taste slightly brackish; it did not turn the syrup of violets green, nor did it contain a single particle of lead. The portion which was not dissolved in the water, being treated by the means most proper for discovering this metal, did not shew the slightest trace of it. (Merat, Op. Citat. p. 122.)

SECOND CASE.

The whole of the Poison has been swallowed: the Matter vomited can be acted upon, as well as that found in the Digestive Canal after the Death of the Patient.

776. After having expressed the fluid portion through a piece of fine linen, it must be assayed by the tests which served to discover the existence of the salts of lead (§ 755); and if the precipitates obtained are of a nature to induce a belief, that the fluid contains some preparation of this kind, it must be evaporated to dryness, and calcined with charcoal in a crucible; at the expiration of three quarters of an hour, of a red heat, metallic lead will be obtained, the characters of which have been shewn § 744 et seq.

It has very often happened in the experiments I have made on this subject, that the fluids vomited contained scarcely any of the acetate of lead, whilst the solid matter with which they were mixed, contained a tolerable quantity of this salt in a solid state. Without enquiring into the cause, which under these circumstances, opposes the solution of the acetate in cold water, the practitioner will proceed to boil all the solid portions in distilled water; and if the fluid obtained at the end of fifteen or twenty minutes, and filtered, precipitates like the salts of lead, he will endeavour to separate the metal, in order that he may decide that the poisoning has happened by a preparation of lead.

It must never be forgotten, that the simple examination by the tests, is not sufficient to decide on the presence or absence of metallic poisons. I can assure the reader, that I have in my researches, three different times, seen the matter vomited by animals poisoned by the acetate of lead, which was not at all disturbed by the addition of soluble sulphates; in which the hydro-sulphurets produced a brown colour, without occasioning any distinct precipitate; and which nevertheless con-

tained acetate of lead; since the sulphuric acid instantly converted it into an insoluble white sulphate, and the chromic acid threw down by little at a time, chromate of lead of a canary-yellow colour. (§ 755, *A* and *F*.)

777. If all the experiments made on the fluid portion of the matter vomited, should become fruitless for discovering the poison, the whole of the solid portions previously dried, should then be calcined with potash and charcoal; by this means metallic lead will be obtained. If we reflect ever so little on the facility with which broth, albumine, milk, the sulphates, muriates, food, &c., decompose the soluble salts of lead, which they convert into an insoluble substance, we shall perceive how very rarely it can happen, in the kind of poisoning we are treating of, that a greater or less quantity of this metal is not found in the solid matter vomited. Wherefore, by the aid of the proceeding which we recommend to be put in practice, the physician will always succeed in decomposing or carrying off from the metallic lead, all the principles with which it was combined.

778. Should the juridical physician be required by the magistrate to discover the metal after the death of the person, he will proceed to act as we have already directed, after having carefully collected all the solids and fluids contained in the stomach, as well as the flaky mucous covering which lines the interior of the digestive canal: he must not neglect either, to submit to calcination the mucous membrane of such portions of the canal as shall have undergone any alteration.

TREATMENT OF POISONING BY THE COMPOUNDS OF LEAD.

779. Does there exist any antidote to saturnine preparations introduced into the stomach?

Navier, in his work on antidotes, decides in the affirmative, and points out the alkaline sulphurets as antidotes to these compounds.

Experiment 1st. The œsophagus of a small dog was detached and perforated: two drachms of acetate of lead dissolved in an ounce of distilled water, mixed with two drachms and a half of sulphuret of potash dissolved in two ounces of water, were introduced into the stomach; the œsophagus was then tied to prevent vomiting. The animal experienced nothing remarkable the first day. The next day he was dejected, but did not appear to suffer pain. On the third day the dejection increased, and he died in the night of the fourth day. The mucous membrane of the stomach was all corroded, and in a state of suppuration: the muscular coat was of a pale red colour in some parts.

Experiment 2d. After having detached the œsophagus of a dog, a perforation was made in it, through which there were introduced into the stomach an ounce and two drachms of acetate of lead dissolved in three ounces of water; five minutes after, seven drachms of sulphuret of potash, dissolved in six ounces of water, were introduced into the same viscus, and the œsophagus tied below the opening. The animal died at the expiration of three hours, after experiencing very violent convulsive movements. On opening the body, the stomach was found filled with food and the fluids introduced; in which was seen a great quantity of sulphuret of lead of a blackish colour; this viscus exhaled the smell of rotten eggs extremely fetid. The mucous membrane was blackened by a covering of sulphuret of lead very brilliant; but it did not appear to be corroded: there was nothing remarkable in the intestines.

These facts prove, 1st. That the sulphuret of potash decomposes the acetate of lead in the stomach, and converts it into an insoluble sulphuret: 2nd. That notwithstanding this decomposition, poisoning takes place, since one of these animals experienced convulsive movements, and died three hours after having taken the poison; and in the other, the disorganization of the stomach was exceedingly advanced.

In comparing attentively the lesions of texture observed in those animals which died after having taken this sulphuret, both in the experiments we have just been relating, and in those which had for their object the mercurial and coppery poisons, there has appeared to me to be a great similarity between them, and that they might all have depended on the same cause; that is, the corrosive and poisonous properties of the sulphuret of potash employed. I made some trials on dogs, and was very soon convinced, that this pretended antidote introduced into the stomach in the dose of three drachms, dissolved in two ounces of water, strongly excited vomiting, and proved fatal to all those who had the œsophagus tied, in the space of two or three hours, inducing horrible convulsions, and an active inflammation of the texture of the stomach; (Vide article *Hydrogenated Sulphuret of Potash*, near the end of this volume.) Now, since one of the most essential qualities of an antidote is, that it may be administered in a large dose without inconvenience, it follows that the sulphuret of potash, the action of which is extremely energetic, ought to be rejected from the class of medicines which we are now treating of, in order to be arranged in the list of poisons drawn from the mineral kingdom.

780. The facility with which the sulphates of soda, magnesia, &c., decompose the salts of lead, the insolubility of the metallic sulphate resulting from this decomposition, and the possibility of giving to the patients a sufficient quantity of these sulphates without any serious symptoms being occasioned by them, were the considerations which induced me to try whether these kinds of salts would not furnish the antidotes to saturnine preparations.

Experiment 1st. A feeble dog, of middle size, was made to swallow nine drachms of sulphate of lead, finely powdered. The animal felt no inconvenience, and the next day ate as usual.

Experiment 2nd. At ten o'clock the œsophagus of a dog

of middle size was detached and perforated; ten drachms of acetate of lead dissolved in three ounces of distilled water, were introduced into the stomach; eight minutes after, an ounce and half of sulphate of magnesia dissolved in three ounces of water, were introduced into the same viscus, and the œsophagus was tied below the opening to prevent vomiting. At the end of ten minutes, the animal made violent efforts to vomit, and had a liquid stool, in which some white clots were seen, of an earthy appearance, and which furnished on analysis sulphate of lead. He fell into a state of dejection, and died the next day at four in the morning, after having passed two other stools.

Dissection. The stomach contained a great quantity of sulphate of lead; the mucous membrane of this viscus, which was of a clear red colour throughout its whole extent, exhibited in the portion corresponding to the pylorus, a few spots of a purple red colour: the other two coats of the stomach were only slightly injected.

Experiment 3d. Being persuaded that in the foregoing experiment, the whole of the poison had not been neutralized by the sulphate of magnesia, it was tried again upon an animal of small size, which was placed under the same circumstances, excepting that he was made to take only two drachms and a half of acetate of lead, dissolved in an ounce and half of water; and six minutes after, four drachms of sulphate of magnesia in one ounce of water were given him. The animal experienced nothing that could be perceived; at the end of eight days he was dejected, extremely lean, and scarcely alive. He expired on the ninth day from the operation. On opening the body, the stomach and intestines were found in their natural state.*

* Two drachms and a half of acetate of lead, without the addition of sulphate of magnesia, constantly killed all the dogs who had the œsophagus tied, in two or three days' time, and their texture was found more or less inflamed.

It follows from these facts: 1st. That the sulphate of lead may be swallowed with impunity in a large dose. 2nd. That the sulphate of magnesia decomposes the acetate of lead in the stomach, and transforms it into an insoluble sulphate of lead. 3d. That the corrosive effects of this poison are prevented by a sufficient quantity of sulphate of magnesia, and the contrary happens when this salt is not taken in sufficient quantity to effect the total decomposition of the poisonous substance. 4th. That the sulphate of magnesia is a true antidote to the acetate of lead.

There is no doubt but that the other saturnine preparations would be equally decomposed, and transformed into insoluble sulphates, by the addition of sulphate of magnesia, or *of any other soluble sulphate.*

781. We see then, that in a case of the ingestion of any drink containing a soluble salt of lead, the first duty of the physician, is to cause the patient to take copious draughts of water, containing three or four drachms of sulphate of magnesia, soda, or potash, to each pint. The course he ought to take is altogether different, when the case of poisoning has happened from saturnine emanations; for instance, in any of the numerous cases of painter's colic.

In the hospital, called the *Charité,* at Paris, a treatment has been adopted for several years past, the efficacy of which is perfectly acknowledged at this day. It is very uncommon to meet with a case of simple lead colic, which does not yield to this method of cure when wisely conducted. It is as follows.

On the day of the patient's reception, the painter's purgative glyster is administered, composed of four ounces of senna leaves, boiled in a pint of water, and which is afterwards mixed with half an ounce of sulphate of soda, and four ounces of emetic wine. (*Vin. Antimon. Tart.*)

In the course of the day the following drink is given:

Take of Simple Cassia,* 2 pints.
Epsom Salts, 1 ounce.
Emetic Tartar, 3 grains.

Sometimes, if the patient be robust, there is added,

Syrup of Buckthorn, 1 ounce.
or, Confection Hamech, 2 ounces.

In the evening an anodyne glyster is administered, made with six ounces of nut oil, and twelve ounces of red wine. There is given internally a drachm and half of theriaca, with which is incorporated, according to circumstances, a grain and half of opium.

The second day in the morning, there are given at twice, with the interval of an hour, six grains of tartar emetic dissolved in eight ounces of water. When the patient has done vomiting, he is made to take during the rest of the day the following sudorific ptisan:

Take of Guaiacum, China root, Sarsaparilla, } of each one ounce.

Boil them for an hour in three pints of common water.

Reduce that to two and then add:

Sassafras, 1 ounce.
Liquorice, 4 ounces.
Boil them gently and strain.

In the evening, the anodyne glyster and theriaca with the opium, as on the first day.

* The water of *simple cassia* is thus prepared:

Cassia pods bruised, 2 ounces.
Water, 2 pints.
Boil for a quarter of an hour, and strain.

The third day, the patients take, at four different times, in the forenoon, the laxative sudorific ptisan, which is made thus:

Simple Sudorific Ptisan,	2 pints.
Senna,	1 ounce.

Simmer it a few seconds, and strain.

During the day the simple sudorific ptisan: in the evening the painter's purgative glyster; two hours after, the anodyne glyster, and theriaca with opium.

The fourth day, the following purgative is administered.

Take of Infusion of Senna,*	1 ounce.
Glauber's Salts,	4 drachms.
Jalap, in powder,	1 drachm.
Syrup of Buckthorn,	1 ounce.

In the evening, the glyster of oil and wine, and the theriaca; during the day, they are made to take for drink, the compound decoction of guaiacum.

The fifth day, the laxative sudorific ptisan; in the evening, at four o'clock, the purgative glyster; at six, the anodyne glyster; and theriaca with opium at eight.

The sixth day, the painter's purgative is given, with the simple sudorific ptisan, the anodyne glyster, and the theriaca with opium, as on the fourth day.

Should the patients, notwithstanding the use of all these means, have no evacuation, the painter's purgative pills are had recourse to.

Take of Diagrydium,† Resin of Jalap,	of each 10 grains.
Gamboge.	12 grains.
Confection Hamech,	1 drachm and half.

* This is prepared with two drachms of senna and eight ounces of water, which is reduced to six by ebullition.

† Diagrydium is a preparation of Scammony with Sulphur and mucilage of Quince.

Syrup of Buckthorn, a sufficient quantity to make of the whole twelve boluses, to be administered at intervals of two hours each.

We shall conclude our remarks on the treatment at the *Charité*, by an observation taken from the works of M. Merat: " I attended," says he, " six or seven years ago an apothecary " who manufactured a great quantity of the *Salt of Saturn*, " and who was attacked by the metallic colic. I wished to " enter upon the treatment of the *Charité*, but the patient " vomited the ptisans: the tartar emetic largely diluted only " passed: and I was consequently reduced to this only means. " His colic was cured in eight days, after having taken about " eighty grains of emetic tartar, in drinks and glysters. A si- " milar method might be employed under such circumstances. " Perhaps, we might even try if it would not succeed in all " these colics; in which case, this treatment might supersede " the other, which is beyond every thing nauseous to the pa- " tient." (page 163.)

782. The antiphlogistic method, so particularly extolled by Dehaen, Borden, and Tronchin, is not suitable, and ought to be abandoned in the treatment of the painter's colic produced by saturnine emanation; the case would be different, however, if the patient had swallowed some compound of lead, and was suffering under unequivocal symptoms of inflammation of one or more of the abdominal organs.

My countryman, Doctor Luzuriaga, who has published an excellent dissertation on this disease, very properly recommends to give to the patients attacked with it, a grain of opium every three hours.*

783. Castor oil, baths, blisters, mercurial preparations, sulphate of zinc, sulphur, alum, bitter salts, alkalies, acids, cam-

* Disertacion medica sobre el Colico de Madrid, inserta in las memorias de la real Academia Medica de Madrid, por el Doctor Don Ignacio-Maria Ruiz de Luzuriaga, Socio de las reales Sociedades de Medicina e Historia Natural de Edimburgo, &c. Madrid, 1796.

phor, musk, oxygen, chamomile, extract of colocynth, balsam of Peru, and an infinity of other medicines, have in their turn been proposed by various practitioners, to combat the symptoms produced by this disease. Experience has not yet ascertained the respective value of these remedies, several of which are evidently of no utility.

ADDITIONS.

OF IODE.*

M. Courtois has of late discovered a peculiar substance in the soda of Varec, the principal properties of which have been made known by M. Gay-Lussac, and to which he has proposed to give the name of Iode, on account of the violet colour which it exhibits when reduced to the state of vapour. The experiments which we have made upon ourselves, and upon dogs, leave no doubt as to this new body being endued with poisonous properties, capable of destroying any animals to whom it is given in the dose of two or three drachms. Before examining its action upon the animal economy, we shall proceed to detail its chemical and physical history, which appears to us indispensable, in order to distinguish it from other deleterious substances.

CHEMICAL HISTORY OF IODE.

784. Iode is solid at the ordinary temperature; it is met with under the form of small plates of a bluish colour, of a metallic lustre, of feeble tenacity, and having the appearance of plumbago (carburet of iron); its smell resembles that of sulphur oxy-muriate *(soufre oxi-muriate)*: its specific gravity is, as 4,946.

* This word is derived from ἴον, *a violet, unde et* ἰοειδὴς, *violaceus*, of a violet colour. It is named by English Chemists, *Iodine*.—Translator.

785. If a small plate of iron be heated, and a certain quantity of iode thrown upon it, it evaporates, diffusing very beautiful violet-coloured vapours. If these vapours be collected in a glass bell, it will be seen that they condense again to form afresh the crystalline plates we have spoken of.

786. Iode communicates to water a slight tint of amber yellow, and dissolves only in very small quantity. If water mixed with this new body be heated in a phial, it quickly evaporates, passing through the fluid, and diffusing a beautiful violet smoke.

787. Iode has a very great affinity for hydrogen, which it carries off from a very great number of bodies. The product of this combination is a new acid, to which has been given the name of *hydriodic acid*. Oxygen is also capable of combining with it in the state of rising gas, and of forming a peculiar acid, which has been called *iodic acid*. Thus, for instance, when a concentrated solution of barytes is brought in contact with iode, there is instantly formed *hydriodate of barytes*, which is soluble, and *iodate* of this base, insoluble, which proves that the water of the solution has been decomposed, and that the hydrogen has formed with the iode *hydriodic acid*, whilst the oxygen has converted another portion of this new body into *iodic acid*.

788. When a mixture is made with distilled water, iode, and metallic zinc, and the temperature is raised ever so little, there is formed a hydriodate of zinc which remains in solution, and from which the oxyde can be separated by means of potash; there is no gas liberated.

Rationale. The water is decomposed; the oxygen unites with the zinc, whilst the hydrogen brings the iode to the state of hydriodic acid, which dissolves the oxyde that has been formed.

789. The action of iode upon vegetable and animal substances, has hitherto only been examined generally; it is only known that almost all organic substances are decomposed by

this new body, which carries off from them a great part of their hydrogen, in order to become hydriodic acid.

ACTION OF IODE UPON THE ANIMAL ECONOMY.

Experiment 1st. At twelve o'clock, a dog of middle size was made to swallow two drachms forty-eight grains of iode: immediately after, the animal had his mouth full of a yellowish foam, and made motions of deglutition, which were often repeated: at three o'clock, he had not yet had any evacuation; at five he had a stool, not very copious, composed of solid matter stained yellow, and of a paste-like matter of a bluish colour, in which a portion of the poisonous substance ingested could be distinguished; this matter possessed the smell of iode; on being dried, and exposed to the action of heat, it exhaled a beautiful violet-coloured vapour, and yielded on sublimation, half a drachm of bluish crystalline plates formed by this new body (§ 785). At six o'clock the animal vomited a very small quantity of soft matter, of a deepish yellow colour; these vomitings were repeated ten minutes after; he appeared rather dejected, but uttered no plaintive cry. The next day, he refused food and drink; he lay down on his belly, and breathed without difficulty; his movements were perfectly free. On the third day he continued to be dejected; the pulsations of the heart were very frequent, and he would not take any nourishment. At six in the evening, he had a fresh stool, in which it was impossible to discover the least vestige of iode. On the fourth day he refused to take milk, had a hiccough from time to time, and shewed no other remarkable symptom except dejection. In the night of the seventh day, he had another stool, and expired two hours after, without having shewn any sign of paralysis, convulsion, or vertigo.

Dissection. The stomach was empty and contracted: its internal surface was covered with a mucous lining, which was

thick, extremely tenacious, and of a yellow colour; the mucous membrane exhibited, towards the cardia, seven or eight small ulcers in a line, forming angles between them: these ulcers, which were surrounded by a yellow aureola, were the consequence of the action of the iode upon the edges of the folds of the mucous membrane. On examining the ulcerated parts, by holding them up to the light, the denuded spots exhibited a very sensible transparency. There were seen towards the great extremity, a few spots of a clear yellow, and some of a yellow bordering on brown; these spots, when lightly rubbed with the handle of a scalpel, were easily removed; the same thing took place with the mucous membrane with which they were united. Near the pylorus were a very great number of folds, the prominent edges of which were strongly stained yellow, whilst their lateral parts were in the natural state. These folds could scarcely be extended ever so little, but the mucous membrane tore; which prove that there was incipient ulceration. The portion nearest to the pylorus was of a deep green colour, rather dirty. When the coloured covering was lifted up, which concealed the coats of the stomach in that place, the mucous membrane was found to be inflamed through its whole thickness. The muscular coat corresponding to this part was likewise in a state of phlogosis. The interior of all the small intestines was found to be coated with a yellow mucosity, mixed with blood, and in great abundance. The lungs, which were shrivelled up, were crepitating. The liver, spleen, and bladder, appeared to be in their natural state.

Experiment 2nd. At one o'clock, a small dog was made to take fasting, a drachm and twelve grains of iode: the animal immediately performed the movements of deglutition, and at the end of eight minutes vomited a soft matter stained yellow, in which was found a part of the iode he had taken. These vomitings were repeated four times in the first eighteen minutes after taking the poisonous substance into the stomach.

At two o'clock he appeared to suffer pain; he had hiccough, and continued making the movements of deglutition: he was lying on the belly. The next morning, he ate with tolerable appetite. At the end of six days he appeared perfectly recovered, and devoured the food given to him. He escaped ten days after the poisoning.

Experiment 3d. A dog of middle size was made to take a drachm of iode; at the end of twenty minutes, he vomited a white, frothy matter, tinged with yellow in several places: he performed the movements of deglutition. Ten minutes after, he vomited again some albuminous, stringy matter, of a saffron colour; these vomitings were twice repeated in the course of half an hour: the animal was somewhat dejected, and refused food. The next day, he fed very well, and appeared perfectly recovered at the end of four days.

Experiment 4th. A dog of middle size was made to swallow a drachm and eighteen grains of iode: two hours afterwards, the animal had not vomited, he was greatly agitated, and often put out his tongue, as if to get rid of something which had a disagreeable taste; he had the hiccough, and lay down on the belly. Three hours after the ingestion of the poison, he vomited a small quantity of brownish matter, of the consistence of paste, in which no iode could be found. The next day he refused food, and fell into a state of dejection. This state continuing for five days, the animal expired without shewing the least sign of paralysis or convulsion.

Dissection. The interior of the stomach presented the yellow tinge and ulcerations we have spoken of in experiment 1st. The muscular and mucous coats were a little inflamed in patches; it was impossible to discover the least trace of iode in any part of the digestive canal.

Experiment 5th. The œsophagus of a small dog was detached and perforated; one drachm, forty-eight grains of iode enclosed in a little paper cone were then introduced into the stomach, and the œsophagus was tied below the opening to

prevent vomiting. The animal made some efforts to vomit at the end of two hours. The next day he was dejected: his breathing was performed freely; and he was not paralyzed. He died on the morning of the sixth day, in a very great state of dejection.

Dissection. The interior of the stomach did not appear inflamed; the mucous membrane was abraded near the cardia, where it presented several tolerably extensive ulcerations; the muscular membrane was also ulcerated in several of the corresponding points. These ulcerations, which were more decided than in the animal which formed the subject of the first experiment, observed nevertheless the same longitudinal disposition. Near the pylorus was seen a yellow mucous covering, tolerably thick. The intestinal canal exhibited nothing remarkable. The lungs were sound.

Experiment 6th. At seven o'clock in the morning, the œsophagus of a small dog was detached and perforated, and three drachms of iode enclosed in two little paper cones were introduced through the opening: this organ was then tied, to prevent vomiting. At the expiration of six minutes, the animal made violent efforts to vomit. At ten o'clock he had the hiccough, and appeared to suffer some pain. At eleven at night, he uttered acute plaintive cries, and was greatly dejected; he had no evacuation during the day. The next day his dejection was extreme; the pulse beat a hundred and forty strokes in a minute, and the animal was tormented by an ardent thirst: he passed during the night one solid stool, not very copious. He died at two o'clock.

Dissection. On opening the œsophagus, there was found a drachm and half of iode, which had not been pushed into the stomach: this organ exhibited, near the cardia, and in the vicinity of the pylorus, several spots of a purple red colour; the mucous membrane, corresponding to the great curvature of this viscus, was ulcerated in four different points: the ulcers, which were of a round form, did not affect the muscular coat.

The coats of the œsophagus were extremely yellow, and had acquired a considerable hardness; they presented as much resistance as those of the trachea.

These experiments being repeated upon other dogs, furnished similar results.

Experiment 7th. A wound was made on the back of a dog of middle size, which was sprinkled over with a drachm and twelve grains of iode, and the flaps were united by two points of suture: the skin grew immediately yellow, and the animal did not appear at all incommoded. The next day he fed as usual. Three days after, the surface of the wound exhibited a yellowish white coat, tolerably thick, and less sensible than the subjacent parts, which were red, and extremely inflamed. At the end of six days, the animal was astonishingly recovered.

Wishing to ascertain the effect of iode upon the human subject, I swallowed two grains of it, fasting. A horrible ill taste, and some slight nauseas, were the only symptoms I felt from this poisonous substance. The next morning I took four grains of the same substance: I instantly felt a constriction and heat in the throat, which lasted a quarter of an hour, and in a short time vomited some yellowish liquid matter, in which the iode could be easily discovered. I was not able to detect any sensible change in the manner of carrying on my functions, unless that I felt a slight oppression during the rest of the day. On the morning of the day after, I swallowed six grains of this poisonous substance, fasting: immediately succeeded heat, constriction of the throat, nausea, eructations, salivation, and epigastralgia: at the end of ten minutes, bilious vomitings tolerably copious, slight gripes which lasted an hour, and which gave way to two emollient glysters. The pulse, which before the experiment beat at sixty, became more frequent, and rose to one hundred and twenty-five, or a hundred and twenty-six, and was beside fuller. Respiration went on freely; from time to time, however, it seemed, in the moment of inspiration, as if I had to overcome some great resistance in order to open the

chest: the heat of skin appeared rather greater than usual; the urine, which was but little coloured, acted with the chemical tests in the same manner as that I had passed before the introduction of the poison. A copious drinking of gum-water, and emollient glysters, put an end to all these symptoms. The next day I felt only a slight fatigue.

We must conclude from all these facts: 1st. That iode, when introduced into the stomach in small quantities, acts as a slight stimulant, and produces vomiting. 2nd. That in the dose of a drachm, it constantly kills in four or five days the dogs who have the œsophagus tied; by producing slowly, ulcerations on those points of the mucous membrane with which it comes in contact. 3rd. That in the dose of two or three drachms, when the œsophagus is not tied, it acts in the same manner upon animals who do not vomit for several hours, even when a part of the poison shall have been expelled by stool. 4th. That it rarely occasions death, when it has been administered in a dose of one or two drachms, and the animals shortly after throw it up by repeated vomiting. 5th. That it does not destroy life when externally applied. 6th. That it appears to act in the same manner upon men as upon dogs. 7th, Lastly, That it ought to be ranked amongst the corrosive poisons.

ON THE ANTIDOTES OF ARSENIC AND CORROSIVE SUBLIMATE.

M. Bertrand, physician of the faculty of Paris, residing at Pont-du-Chateau, has very lately published some experiments which have induced him to believe that the charcoal of wood was capable of arresting the deleterious action of corrosive sublimate and arsenious acid.

The author expresses himself as follows.

(Super-oxygenated Muriate of Mercury.)

" *Experiment* 1st. On the 2nd February, 1811, at ten in the morning, I gave to a dog of six months old, on an empty stomach, six grains of corrosive sublimate, and eight of powdered charcoal of wood, mixed together in a portion of the intestine of a fowl tied at its two extremities. The animal was not at all incommoded by it. In the evening, he ate some broth with an appetite, as well as on the following days.

" *Experiment* 2nd. On the 24th of the same month, at ten minutes after ten in the morning, the same dog again took six grains of super-oxygenated muriate of mercury in butter. A quarter of an hour after, he made most violent efforts, which in a short time brought on repeated vomitings of a glairy matter, which became more and more bloody. He was in a state of agitation truly painful, kept his head constantly down, resting it sometimes on the ground for support, and laboured under tetanic constriction of the jaws. At twenty minutes before one o'clock, warm charcoal water sweetened with honey, was poured down his throat, directing it by one side or other of the openings of the lips, of which I made a sort of funnel. The efforts to vomit, and the bloody vomitings became a little less violent and frequent. At forty minutes after one, I gave him another dose of decoction of powdered charcoal, which, this time, was made thicker, because the animal, whose jaws were not now locked, could more easily swallow it in that state, and from that moment the vomitings ceased entirely. At half-past two the dog appeared still sorrowful, but was quiet, he refused to eat meat, and hindered all other dogs from approaching it by vigorous attacks. At five o'clock he experienced some tenesmus, and began to take a little nourishment. From the next day the natural state of the functions was restored.

" *Experiment* 3rd. On the 6th of February, 1813, at eight

in the morning, I took fasting four grains of corrosive sublimate in a cup of a strong decoction of powdered charcoal, sugared, and rendered aromatic with orange-flower water. At twenty minutes after eight, I felt a small pain, as it were an oppression in the præcordia, with a little heat in the stomach. I felt for an hour a very slight sensation of thirst, which I did not seek to satisfy. At ten o'clock I did not feel the least pain, I breakfasted with a good appetite, and felt no inconvenience from it.

ARSENIOUS ACID.

" *Experiment* 1st. On the 2nd of February, 1811, at five minutes before ten in the morning, I gave to a dog of seven months, upon an empty stomach, six grains of arsenious acid in powder, mixed with eight grains of charcoal of the walnut-tree powdered, the whole being incorporated in a piece of fowl's gut. No immediate or after-effect took place from the ingestion of this mixture, and the animal preserved his liveliness and appetite as usual. He threw up the piece of gut almost untouched, and containing nothing, three days after, during another experiment.

Experiment 2nd. On the 14th of February, 1811, at twenty-five minutes after ten in the morning, I caused a dog of six months, that had eaten nothing that morning, to swallow five grains of arsenic in powder, incorporated in butter. I gave him, almost directly after, some white of egg beat up. No apparent sign of pain, and no evacuation had taken place at noon; but the animal was sorrowful and without appetite four days, at the end of which time, however, his gaiety and ordinary voracity returned.

" *Experiment* 3d. Six grains of arsenic incorporated in butter, were given on the 24th of February, 1811, at noon, to a dog nine months old, whose stomach was empty. Thirty

minutes after the ingestion of the arsenious acid, glairy and slightly bloody vomitings, accompanied by very violent strainings, made their appearance.

" At a quarter before one o'clock, charcoal water, sweetened with honey, was administered. In a short time, the strainings to vomit, and the vomitings themselves ceased. At two o'clock, another dose of the decoction of charcoal sweetened with honey was given: at half-past two, the animal appeared to labour under no impediment in the exercise of his organic functions; he regained his appetite, and at five o'clock he took food in tolerable quantity, and with avidity.

" *Experiment* 4th. On the 16th of February, 1813, at half-past seven in the morning, I took fasting, five grains of arsenious acid in powder, in half a glass of a very strong solution of powdered charcoal of wood, into which I had put some sugar, and distilled water of the flowers of the *tilia*. At a quarter before eight, I experienced a sensation of heat, somewhat painful, in the epigastric region, with considerable thirst; without any further symptoms of consequence. I again took another half glass of solution of charcoal sugared, and rendered aromatic. At half-past nine, the pain and oppressive sensation at the epigastrium had disappeared, and seemed to propagate itself, gently indeed, along the rest of the alimentary canal. Continuing still thirsty, I drank several cups of an infusion of orange-flowers sugared, and at a quarter after ten, without having employed any other therapeutic means, I no longer felt the least pain or inconvenience. At twelve o'clock I dined as usual, without being at all disturbed by it. I have not experienced, since this experiment made upon myself, the smallest derangement in the natural movement of my digestive functions." *

We hastened to repeat M. Bertrand's experiments upon

* Journal Général de Médecine, Decembre, 1813, et Annales de Chimie de Montpellier, Novembre, de la même année.

dogs, multiplying and varying them as much as we judged necessary, and have obtained results which warrant us to affirm, *that neither charcoal nor water of charcoal, are antidotes to corrosive sublimate, or arsenious acid.*

Before entering into a detail of the facts which have induced us to oppose M. Bertrand's assertion, it will be useful to recall to mind, 1st, that we have established it as an axiom, from a multitude of experiments of our own, that any results obtained respecting antidotes, can be of no value, unless the œsophagus of the animal that has swallowed the poison be tied. 2nd. That the name of antidote to corrosive poisons ought not to be given except to those substances which act with sufficient energy upon them, to prevent their inflaming or corroding the texture with which they come in contact. (Vide p. 288, note.) Now charcoal given in a strong dose, does not in any manner oppose the corrosive effects of sublimate or of arsenic, when vomiting is prevented; the same thing happens in almost every case where the œsophagus has not been tied.

Experiment 1st. The œsophagus of a small dog was detached and perforated: four grains of corrosive sublimate perfectly levigated, and mixed in an agate mortar, with a drachm and half of charcoal, which had been passed through a sieve, were then introduced into his stomach, by means of a small paper cone, and the œsophagus was tied below the orifice, to prevent vomiting. The next day the animal had passed no alvine excretions; he had made some efforts to vomit; he was dejected, and uttered plaintive cries from time to time. The dejection went on increasing, and he died at the end of the third day from the operation.

Dissection. The mucous membrane of the stomach was but little red; it presented however near the pylorus, six small ulcers of a circular form, with black edges: the muscular coat corresponding to the ulcerations was red.

An animal of the same size, whose œsophagus was tied,

and that had been made to swallow the triple body, proceeding from two hundred grains of corrosive sublimate mixed with albumine, lived five days and a half, and the digestive canal after death presented no alteration.

Experiment 2nd. At half past ten, the œsophagus of a small dog was detached and perforated: an ounce of charcoal, that had been passed through a sieve, wrapped up in two small paper cones, was introduced into the stomach; immediately after, eight grains of corrosive sublimate dissolved in three ounces of water and mixed with a drachm of powdered and sifted charcoal, were likewise introduced, and the œsophagus was tied. A few seconds afterwards, the animal was considerably agitated; he experienced cruel sufferings, and uttered excessively plaintive cries: he rolled himself on the ground, and he expired at half past two o'clock.

Dissection, immediately after death. The stomach contained about four ounces of a fluid, at the bottom of which was a great quantity of charcoal; the mucous membrane of this viscus, which was of a bright vermillion throughout its whole extent, was evidently inflamed. On analyzing the fluid, it was ascertained that it still contained sublimate. This experiment evidently proves that charcoal in a very strong dose, does not decompose this poison in the stomach.

Experiment 3d. Thirty-five minutes after twelve at noon, the œsophagus of a dog of middle size was detached and perforated. Six grains of corrosive sublimate dissolved in an ounce and half of distilled water, were introduced into the stomach; immediately after, a pint of water, which had been boiled for half an hour upon two ounces of charcoal, afterwards filtered, and in which was suspended a drachm and half of the same substance, was conveyed into that viscus, and the œsophagus was secured. Six minutes afterwards the animal lay down on his belly, and began to make complaints: he made likewise, at different times, fruitless efforts to vomit. At fourteen minutes after one, he was suffering horribly, had

a general trembling, and continued to make efforts to vomit. Twenty minutes after, he passed a stool, composed of liquid matter mixed with a small quantity of solid excrements; he howled frightfully, and made fresh efforts to vomit. At six in the evening, he was extremely dejected; and died in the night.

Dissection. The œsophagus presented no alteration: the mucous membrane of the stomach, which was of a violet red colour (colour of lees of wine) presented several black spots which had the appearance of sloughs, and which were formed by black blood decomposed and affused between this and the muscular coat. On its exterior, this viscus was of a clear red. The intestines were rather inflamed.

The same experiment was repeated upon a small and extremely feeble dog, with this difference, that, instead of the charcoal, he was made to take the white of eight eggs diluted with a pint of water. The animal died at the commencement of the fourth day, without having uttered the least plaintive moan. A few hours before his death, he was dejected, lay down upon his belly, and appeared to suffer some pain. On opening the stomach, no trace of inflammation was found; the mucous membrane only presented a few rose-coloured patches, a colour which seems natural to the mucous membrane of these animals, and which may be seen in those who have not taken any poisonous substance. The intestines exhibited no alteration. The wound of the œsophagus was fetid, black, and gangrenous. It is clear then that this animal did not die from poisoning.*

Experiment 4th. At twenty-five minutes after one o'clock, a small robust dog was made to swallow five grains of corrosive sublimate perfectly mixed with forty grains of charcoal finely powdered. Five minutes afterwards, the animal vomited a

* We think it necessary to inform those who may wish to repeat these kinds of experiments, that it is indispensably necessary, in order to obtain the results we have given, to mix the whites of eggs perfectly with the water, by means of agitation prolonged for four or five minutes.

small quantity of thick matter of a blackish blue colour: these vomitings were repeated four times in the course of the twenty minutes immediately following the ingestion of the poison. At two o'clock, he appeared to suffer pain, and breathed with difficulty: he had a fresh vomiting of bilious matter, after having strained most violently. At seven in the evening, he was lying upon his belly, in a state of great insensibility. It was wished to place him upon his feet; but the posterior extremities were so feeble, that they bent down all at once, and the animal fell instantly upon the side. He expired in the night.

Dissection. The portion of the mucous membrane nearest the cardia presented two circles of the size of a half-crown piece, which were black, hard, and as if tanned; and were with difficulty removed by the scalpel: in the rest of its extent, it was of a bright red colour. The intestines appeared to be in their natural state.

Experiment 5th. At thirty-five minutes after one o'clock, twelve grains of corrosive sublimate triturated with a hundred grains of charcoal, were given to a very strong dog: at the expiration of six minutes, he vomited without effort some alimentary matter blackened by the charcoal; these vomitings had been repeated four times at forty-six minutes after one; he was lying upon the belly, and appeared to suffer a little pain. The next morning, he refused food and drink: he uttered plaintive cries, and vomited blood. From this moment he fell into a remarkable state of dejection, and died on the following day at eight in the evening, fifty-five hours after the ingestion of the poison.

Dissection. The mucous membrane of the stomach was of an extremely deep red throughout its whole extent; it exhibited here and there black spots formed by venous blood extravasated upon the muscular coat. The interior of the small intestines was of a scarlet colour.

Experiment 6th. At twenty-one minutes after one o'clock,

a very strong dog, of middle size, was made to swallow ten grains of corrosive sublimate, dissolved in two ounces of distilled water; five minutes after, he vomited some soft matter in no great abundance. At thirty-one minutes after one, he was made to drink water containing a considerable quantity of charcoal in suspension, which he soon vomited. At forty minutes after one, he was made to take a fresh dose of finely powdered charcoal and water; in three minutes more, he had copious vomitings. Lastly, at fifty minutes after one, he was again forced to swallow charcoal suspended in water, and vomited at the end of two minutes. He had not ceased to suffer since the moment of the ingestion of the poison; he uttered plaintive moans, and rolled himself several times on the ground. The quantity of charcoal taken, might be estimated at half an ounce, and the water in which it was suspended, at twelve ounces. At seven in the evening, he vomited blood, and experienced cruel torments. The next morning he refused meat and drink, and died at six the same evening.

Dissection. The stomach was hardened: the inflammation of the mucous membrane was extended to the highest degree; this coat was black and extremely hard. The intestines, which were red withinside, were evidently inflamed.

On the same day, at ten minutes after eleven, nine grains of corrosive sublimate dissolved in two ounces of distilled water, were introduced into the stomach of a small dog, extremely feeble: the animal suffered much, and fell into such a state of dejection, that all the pupils who were present believed him dead. A quarter of an hour after, coming to himself, he vomited for the first time, some white matter, not very abundant. There was immediatly given to him some water beat up with albumine; he vomited it at the expiration of five minutes. At forty minutes after eleven, he was again made to take some albuminous water, which was not rejected. Fourteen minutes after, more was given to him, and he did not

vomit it. The quantity of drink he took might be estimated at fourteen ounces of water, containing the albumine of seven or eight eggs. In the evening he appeared fatigued, and somewhat dejected. The next day he ate with an appetite, and was in excellent health twenty days after the experiment.*

Experiment 7th. At twenty-five minutes after one o'clock, a dog of middle size was made to take six grains of corrosive sublimate dissolved in two ounces of water and mixed with a drachm of charcoal: at the end of two minutes he vomited a great quantity of black matter: he rolled himself on the ground, in a state of great agitation, and vomited some white and frothy matter in no great quantity. At forty minutes after one, he was made to swallow a drachm of charcoal suspended in half an ounce of water, and he did not vomit it: the same quantity was given him ten minutes after, and he did not vomit it. At seven in the evening, he uttered plaintive cries, and was lying down on his belly. The next day he ate a piece of bread, and continued to make complaints. On the third day, he was sufficiently active: he took food, and made his escape. Did this dog die? we believe not, considering the situation he was in on the day of his escape. But can we

* Several experiments which we have made upon other animals placed under the same circumstances as the above, have not proved so fortunate: it often happens that they die when the albumine is given to them, several minutes after having swallowed the sublimate. This almost always depends on the impossibility which exists of making them take it when they begin to feel the pains from the caustic: and even when we have succeeded by means of tubes, to introduce into their stomach a certain quantity of it, they use their utmost efforts to throw it up before it can have had time to decompose the poison. But, we repeat it, rigorous conclusions cannot be drawn, either in favour of or against the chemical re-agents proposed as antidotes, except when the œsophagus of the animal has been tied: for which reason we look upon the sixth experiment as of little value for combating the assertion of M. Bertrand. We have only reported it on account of the similarity that exists between its results, and those which we are endeavouring to establish in order to demonstrate the inefficacy of charcoal in cases of poisoning by corrosive sublimate.

conclude that, in this experiment, the charcoal prevented the fatal effects of the corrosive sublimate? Certainly not: is it not probable that the animal owed his recovery to the speedy expulsion of the poison, which had beside been partly decomposed by the alimentary matter, which was found in sufficient quantity in the stomach?

Experiment 8th. At one o'clock the œsophagus of a dog of middle size was detached and perforated. A paper cone was then introduced into his stomach, containing six grains of arsenious acid, perfectly reduced to powder, and mixed with fifty grains of sifted charcoal; the œsophagus was tied below the opening in order to prevent vomiting. At the end of twelve minutes, the animal made efforts to vomit: at three o'clock he had a bloody stool, and was suffering considerable pain. He died five hours after the ingestion of the poisonous substance.

Dissection. The mucous membrane of the stomach was of a black red; the inflammation extended to the muscular coat of this viscus; the interior of the intestines presented some red spots.

Experiment 9th. A wound was made upon the back of a very strong dog, and was sprinkled over with a drachm of arsenious acid very finely powdered, and intimately mixed with three drachms of charcoal; the flaps were afterwards united by three points of suture; the animal experienced all the symptoms of poisoning, and died at the end of eighteen hours.

Dissection. The mucous membrane of the stomach was of a cherry red throughout almost its whole extent; the intestines were a little inflamed.

Experiment 10th. A very strong dog was made to swallow two boluses composed of about half an ounce of lard, and of nine grains of arsenious acid, mixed with forty grains of powdered charcoal: at the end of an hour he vomited some thick matter, of a blackish blue colour, in tolerable abundance,

amongst which the lard ingested was easily to be distinguished. The next day the animal was in excellent health.

Experiment 11th. A small black dog was made to swallow six grains of arsenious acid mixed and triturated with seventy-two grains of charcoal; at the end of a quarter of an hour the animal vomited some black and thick matter, and the next day appeared perfectly well.

Experiment 12th. Wishing to ascertain whether the success of the two preceding experiments depended on the poison being enveloped or divided by the substances with which it had been given, rather than to any chemical action, we gave to the little dog just spoken of, six grains of arsenious acid, finely powdered, and mixed up with a drachm of clay. At the expiration of half an hour, the animal vomited some earthy matter in no great quantity; these vomitings were repeated six minutes afterward; and the next day he was perfectly recovered. In another experiment, sand was substituted for clay, and the results were the same.

These experiments are far from proving that charcoal is the antidote to arsenious acid; for in this case we must admit, that clay, sand, and many other substances which are pulverulent and insoluble, are so likewise; it is moreover evident that the effects produced by either one or the other of these powders, cannot take place, unless when they are administered with the arsenious acid, which they envelope and divide. It will be useless to attempt to diminish or arrest the action of this poison, by administering after its ingestion, either charcoal, or any other pulverulent substance.

OF HYDROGENATED SULPHURET OF POTASH.

(LIVER OF SULPHUR DISSOLVED IN WATER.)

Navier, and several other respectable physicians, have

greatly extolled the solution of liver of sulphur, as an antidote in cases of poisoning by corrosive sublimate, arsenious acid, salts of copper, and preparations of lead. We have shown in the course of this work, that this re-agent does not prevent the effects of these poisons, and consequently that it is of no use. Experiments made with the utmost care, warrant us to affirm, that far from regarding this substance as an antidote, it ought to be ranked amongst the most energetic of corrosive poisons. Let us support this proposition with some facts.

Experiment 1st. At twelve o'clock, the œsophagus of a very strong dog was detached and perforated: six drachms and a half of liver of sulphur of commerce dissolved in four ounces of water, were introduced into the stomach, and the œsophagus was then tied to prevent vomiting. The animal instantly appeared to be suffocated; he experienced an excessive degree of anhelation during two minutes; immediately after, the limbs became stiff, and the muscles were in a state of great contraction; the head was strongly reflected back, and every part of the body was agitated with convulsive movements. Five minutes after the operation he was lying senseless on his side: the muscles that move the lower jaw were in such a state of convulsion, that their movement produced several times in the course of a minute, an approximation of the two jaws, so as to occasion a very smart sound by the shock of the inferior row of teeth against the superior. He died at seven minutes after twelve.

The *Dissection* took place immediately. The heart was contracting strongly: the left ventricle contained black blood; the lungs, which were crepitating in several parts, exhibited some hardened portions, containing a little air. The stomach was filled with hydrogenated sulphuret of potash of a clear yellow colour. The mucous membrane of this viscus was much wrinkled, and sprinkled over with an infinite number of small bright red spots; it was covered with a greenish yellow

lining, thick, and easy to detach; the same kind of lining was found over the whole internal surface of the small intestines.

Experiment 2nd. At twenty-five minutes after eight o'clock, the œsophagus of a small robust dog was detached and perforated: three drachms and a half of liver of sulphur dissolved in two ounces and a half of water, were introduced into the stomach; the œsophagus was then tied below the opening, to prevent vomiting. At the end of ten minutes, the animal made violent efforts to vomit; his breathing became deep and accelerated, and he was much less active than before the operation. The efforts to vomit were repeated five times in the course of the first half hour, which succeeded to the ingestion of the poisonous substance. At ten minutes after nine, the posterior extremities were weak, extended one from the other, and somewhat bent: his breathing was accelerated, and he had a stool, in which was a tolerable quantity of solid excrement, of a yellowish tinge. At eleven, he was agitated with convulsive movements, and died half an hour after. Death was preceded by an attack of tetanus which lasted two minutes.

Dissection. The lungs presented two hardened lobes, less crepitating than in their natural state. The mucous membrane of the stomach was wrinkled, and sprinkled over with yellowish white spots, which were detached from a ground of deep green. These spots, from their arrangement, gave this coat the appearance of a certain kind of toads; when carefully examined, an innumerable quantity of small blackish spots were perceived. On dissecting off this membrane, there were found on the surface adhering to the muscular coat, spots of a very deep brownish red, formed by extravasated blood, and corresponding exactly to the white spots on its other surface. The muscular coat was of a brown red colour on that part which adheres to the mucous membrane; on its external surface it was green, and strongly injected. The stomach con-

tained no fluid; it presented only a thick yellow lining, resembling sulphur in colour. The duodenum and the commencement of the jejunum were strongly inflamed.

Experiment 3rd. At twelve o'clock, the œsophagus of a strong dog of middle size was detached and perforated: a drachm of liver of sulphur dissolved in an ounce of water, was then introduced into the stomach, and the œsophagus tied below the opening to prevent vomiting. A quarter of an hour after, the animal made, at several different times, violent efforts to vomit. At one o'clock he had a liquid stool, in which were some solid excrements of a yellowish colour, his breathing was rather accelerated, and he began to complain. At seven in the evening, he was lying upon the side; he appeared to suffer pain in the abdomen, and continued to breathe with difficulty; he still preserved, however, the power of moving his limbs, and was not agitated by any convulsive movement. He died during the night.

Dissection. The state of the body left no doubt of the animal's death being preceded by an attack of tetanus. In fact, the head was strongly bent backwards, the posterior members were extended from one another, stiff, and considerably elongated. The mucous membrane of the stomach presented several circular ulcerations of the size of a sixpence; the parts not ulcerated were sprinkled over with black spots, formed by extravasated venous blood. The muscular coat was of a bright red colour throughout its whole extent. The lungs exhibited the same alteration as in the preceding experiment.

Experiment 4th. Two drachms and a half of liver of sulphur, dissolved in two ounces of water, were injected into the stomach of a dog of middle size. At the end of ten minutes he vomited, at three different times, a great quantity of alimentary matter mixed with a part of the poisonous substance: his breathing became difficult, and he became dejected in the course of the day. The next day he ate with appetite, and did not appear at all sick.

It is evident, from the preceding experiments, that the animals that might chance to take a stronger dose of liver of sulphur, would die at the end of a space of time which is variable, even when a part of it may have been rejected by vomiting.

We conceive that we may conclude from these facts, 1st, that the hydrogenated sulphuret of potash, introduced into the stomach, occasions death, by acting on the nervous system, and by strongly corroding the membranes of the stomach: 2nd, that the corrosion is more slight in proportion as the dose of the sulphuret administered is stronger, the nervous phenomena being in this case much more severe.*

Experiment 5th. Eight grains of liver of sulphur dissolved in six drachms of distilled water, were injected into the jugular vein of a dog of middle size. The animal instantly experienced the most violent convulsive movements; his head was bent backwards, and he beat himself about. These phenomena ceased at the end of three minutes, and the next day the animal was perfectly recovered. Twenty-two grains of the same sulphuret dissolved in an ounce of water, were then injected into the jugular vein of the opposite side. The injection was hardly finished, when the animal was seized with the same symptoms as before, and expired at the end of two minutes.

* M. Magendie has observed, that when a drop of a strong solution of liver of sulphur was put into the mouth of a very young dog, the animal died in a short time; and he found after death, the trachea filled with mucosities.

The reader may have observed, in the history of several of the corrosive poisons spoken of in this work, that their effects upon the animal œconomy were different according to the dose in which they had been administered. Such a poisonous substance, for instance, that, in the dose of a few grains, strongly inflames the substance of the stomach, and produces nervous symptoms but very obscurely marked, taken in a much stronger dose, destroys life in a very short time, acting with great energy upon the brain and upon the vertebral column. This extraordinary fact did not escape the sagacity of professor Emmert, a learned physician of Berne, who has been occupied, and very successfully, on the physiological action of poisons upon our organs.

He was immediately opened. The blood contained in the ventricles of the heart was fluid; that which filled the left ventricle was of a deep red colour. The lungs were a little shrivelled, and contained a sufficient quantity of air.

The hydrogenated sulphuret of potash then, when introduced into the stream of the circulation, produces death by acting particularly on the nervous system.

790. The liver of sulphur may be easily known by the following characters:

1st. It is solid, of a yellow, or red colour: its taste is acrid, pungent, and bitter.

2nd. When brought in contact with water, it partly decomposes it, and passes into the state of hydrogenated sulphuret of potash, which is soluble in the portion of the fluid not decomposed; the hydrogen of the water unites with it, whilst the oxygen converts a part of the sulphur which enters into its composition into sulphureous acid, which combines with a certain quantity of the potash and sulphur, in order to form sulphurated sulphite of potash. All these phenomena are accompanied with the disengagement of a little sulphurated hydrogen gas.

3rd. When exposed to the air, it attracts from it humidity and oxygen, deliquesces, and passes into the state of hydrogenated sulphuret of potash, and sulphurated sulphite of potash.

4th. The solution obtained by either of these processes is of a yellow or red colour; the strong acids instantly decompose it, setting at liberty sulphurated hydrogen gas, known by the smell which it exhales like rotten eggs, and precipitate sulphur. The potash combines with the acid employed, and remains in the solution.

5th. Corrosive sublimate, acetate of lead, the acid nitrate of bismuth, and the salts of copper, yield a black precipitate on the addition of a few drops of hydrogenated sulphuret of potash. The precipitate consists of one or other of these metals combined with sulphur.

6th. Tartar emetic, and the other soluble preparations of antimony decompose the hydrogenated sulphuret of potash, and furnish an orange-yellow precipitate, or one of a reddish brown colour, composed of antimony, oxygen of sulphur, and hydrogen.

7th. The arsenious acid, poured into a small quantity of hydrogenated sulphuret of potash, occasions a white precipitate, which becomes yellow on adding a fresh quantity of the sulphuret (§ 121).

8th. When agitated with metallic mercury, the hydrogenated sulphuret of potash becomes partly decomposed, yields a portion of its sulphur to the metal, and black sulphuret of mercury is soon obtained. This sulphuret becomes red on the addition of a fresh quantity of sulphur.

END OF VOL. I.

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